The
COMMON COMMERCIAL TIMBERS
of
INDIA

and their uses.

(REVISED 1944 EDITION)

By

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In the list which follows R=Indian Forest Record. B=Indian Forest Bulletin and L=Indian Forest Leaflet.

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*R. Vol. 3, No. 5. Suitability and selection of timbers for different uses. Strengths of all important Indian and many Burmese timbers. Parts I & II. As. 6 per part.
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*L. 8. Wooden poles for overhead electric transmission. As. 4.
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General.

Manual of Indian Forest Utilization. Rs. 20. Oxford University Press. Bombay.
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Note 1. Publications marked with a star* are available from Messrs Jugal Kishore & Co., Book-sellers, Dehra Dun, Others from the Manager of Publications, Civil Lines. Delhi.

Note 2. A complete list of publications of the Utilization and other Branches of the Forest Research Institute is available from the President, Forest Research Institute & College, New Forest P. O. Dehra Dun, U. P.

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Preface to First Edition

A great deal has been written, of late years, concerning the "vast forest wealth " of India. The fact remains, however, that except for teak and a few parcels of other timbers from Burma, Madras, and the Andamans, there is practically no export of timber from this country. In the same way, the Indian markets concentrate on teak, sal, deodar and a few other well-known woods, while local craftsmen content themselves with the cheapest timber available, whether suitable for the purpose for which it is intended or not.

This state of affairs could be understood, when the prices of the well-known woods were low, but during the past decade prices have risen considerably, and in some cases are now almost prohibitive to the consumer. Even the large timber users like the Railways, the Ordnance Department, and the Public Works Department began to grow anxious when the price of teak rose to a figure which was beyond all thought fifteen years ago. As a sequel to this unsatisfactory state of affairs, the Railway Board, in 1924 inaugurated an enquiry to investigate the possibility of using timbers other than teak for railway carriage and wagon building and for repairs. The result of this enquiry are recorded in Mr. H. G. Norman-White's Report, published by the Oudh and Rohilkhand (now the East Indian Railway) Press, Lucknow, in February, 1925.

As this report was a railway Board publication and was not available, in a general way, to the public, it was considered that a similar treatise, published by the Forest Research Institute at Dehra Dun, and dealing, not only with timbers suitable for railway work, but also with those woods considered suitable for the general use of Indian timber merchants, both large and small, might serve a useful purpose.

This, then, is the *raison d'etre* of this publication.

At the same time, it has become more and more evident that the technical literature on Indian timbers, published from time to time by the Forest Research Institute, rarely attracts the ordinary layman, and is little read even by timber merchants themselves.

Every effort has been made, therefore, to make the present publication as simple as possible, and it is hoped that it will help to supply a much needed want to the trade.

In this connection, it is only right to mention that Mr. R. S. Pearson, late Forest Economist, published a similar booklet in 1912, namely "A Commercial Guide to the Forest Economic Products of India." This was well received by the trade, and was of invaluable help to many who had known little of the subject. Sixteen years have now passed since that first Commercial Guide was published, and it is by way of bringing Mr. Pearson's Guide, as far as timbers are concerned, up to date in an improved form that the present work is placed before the public.

Before the passing on to the book itself, a special word of warning with regard to SEASONING will not be out of place. The use of unseasoned wood has been the chief stumbling-block to the adoption of India's lesser known timbers, and the importance of proper seasoning cannot be over-emphasized.

A special chapter on air-seasoning, in simple language, has therefore been included in this publication, and if this helps, even in a small way, to eradicate the prehistoric drying methods now carried out by most timber merchants in this country, and to replace them with the simple but no more expensive methods described, then the author will feel more than repaid for his share in this publication.

In conclusion, the attention of the public is drawn to the fact that the new forest products laboratories at Dehra Dun are now the largest, and probably the best equipped of any Forest Research Institute in the world, and the advice and experience of the many specialists employed there are always at the disposal of timber users and others, whether large or small, without any charge. Interested parties are, therefore, strongly urged to write to the Forest Economist, Forest Research Institute, Dehra Dun, whenever they require advice or help in any matter connected with the utilization of Indian timbers or other forest products.

Preface to Second Edition

More than ten years have elapsed since the first edition of this little book was published. During that time knowledge on the subject of Indian woods and their uses has greatly increased, and the time has now come for this knowledge to be placed before the public in a concise and easily readable form.

Judging from the letters of appreciation which were received in connection with the first edition, it would appear that this little book served a useful purpose. Friendly criticisms have also been received, and it is hoped that some of the many shortcomings of the first edition will, at least in part, be made good in this second edition.

One of the chief criticisms had reference to the absence of an index of trade and vernacular names. Such an index has been included in the present edition.

The chapters on the storage of logs, air and kiln seasoning, and the preservation of timber have also been re-written in light of recent research on these subjects, and they now contain the most up-to-date information available.

The number of species described in the first edition has been slightly increased. This has been done at the request of Provincial forest authorities whose help has been much appreciated and is duly acknowledged. Some Burma species have on the other hand been omitted, since Burma is now separated from India.

Special acknowledgement is due to those research officers of the Forest Research Institute who have freely come forward with help and advice on the subjects connected with their work These officers include Dr. S. N. Kapur, Officer in Charge of Seasoning, to whom I am specially indebted for much valuable help, Dr. D. Narayanmurti, Officer in Charge of Wood Preservation, and Mr. V. D. Limaye, Officer in Charge of Timber Testing.

DEHRA DUN,
The 16th October 1940.

H. TROTTER,
Utilization Officer

Preface to Third Edition

The second edition of this book was sold out in under a year because it proved to be especially valuable in time of war. For this reason it was decided to carry out an immediate reprint, which would have left little time for any revision which might be thought advisable. On this understanding the author, Mr. H. Trotter, C.I.E., I.F.S., wrote a preface, stating that very little alteration had been made. Due to the unavoidable delay in printing, it has since been possible to add some subject matter; part of this has been introduced under the original chapter headings, and part in the form of appendices.

It may be felt that the result is neither one thing nor the other. Neither a reprint nor a new edition. This could not be avoided due to the amount of war work which is being handled; as it was, the little that has been done added considerably to the heavy work of the Section Officers of the Utilization Branch of the Institute.

The object of Mr. Trotter's book is to show the difference between India's more important woods and how to use them, to give lists of timbers suitable for the more important purposes, and to explain something of the proper treatment of timber.

E. L. P. Foster.
Utilization Officer,
Forest Research Institute.

Dehra Dun,
The 31th March 1944.

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The tables of strength data given in Appendix I, were compiled by Mr. V. D. Limaye, Officer in Charge Timber Testing Section, Forest Research Institute, Dehra Dun.

Appendix II was drafted by Dr. K. A. Chowdhury, Wood Technologist.

Appendix III was drafted by Dr. Narayanamurti M.B.E. Officer in charge, Wood Preservation Section.

The Forest Research Institute, Dehra Dun.

CHAPTER I.

Storage of logs and preliminary Seasoning treatments.

Most purchasers of timber in India obtain their supplies of wood in the form of logs. It may not be out of place, therefore, if a few words of advice are offered regarding the storage and protection of logs before they are converted.

It is a popular belief that timber can be seasoned in log form as quickly and easily as it can in the form of planks and scantlings. This is not so, and the amount of drying which takes place in a log is, to all intents and purposes, negligible, in comparison with the rapid loss of moisture which can be effected with converted timber. In addition, attempts to season wood in the log, except in a few cases, usually result in considerable loss due to surface and end cracking, and the development of shakes, mould, decay and insect attack.

In any case, the actual drying of wood in log from is extremely slow, even under the best conditions, and experiments have shown that, even after 8 to 10 years, some species have nearly the same amount of moisture in the centre of the log as they had when the trees were felled. The outside portions of such logs will probably have dried out to a certain extent, but, owing to the tension set up in the outside layers, as the result of the inside of the log remaining wet while the outside portion was drying, surface-cracking and the development of shakes are bound to occur. In addition, unless the particular species happens to be fairly immune to insect and fungus attack, as in the case of teak, there is almost certain to be a loss from these causes, in the sapwood portion at any rate.

Seasoning in the log, as far as the actual loss of moisture from wood is concerned, is, therefore, of little use. This point is not realised by most timber users in India, and complaints are often received from people who are greatly surprised to see their converted timber crack and warp, although the logs from which it was cut had been undergoing "seasoning" for some years. They are further surprised when told that the wood in the centre of such logs is probably in much the same condition as when the trees were felled.

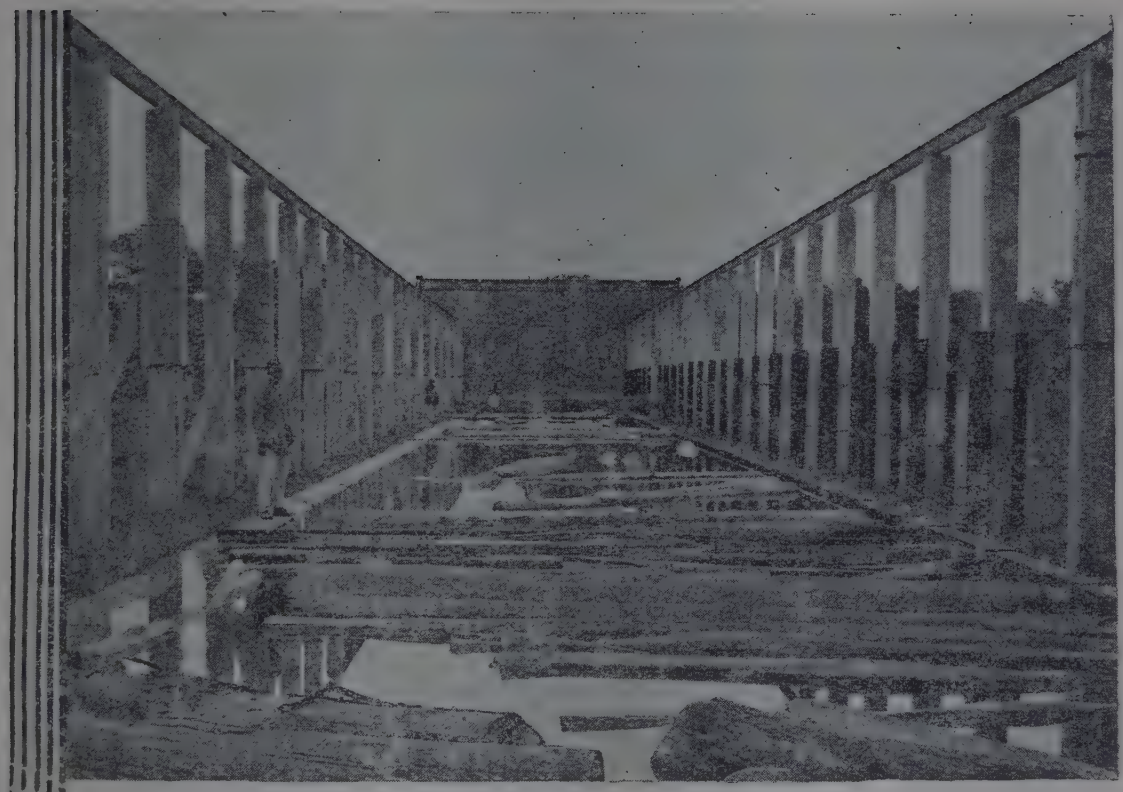
It is, however, possible that the storage of logs, under conditions which protect the wood against too rapid drying of the surface layers, may have a beneficial effect on the subsequent cracking and splitting of the sawn material. Although the moisture

content of wood does not change appreciably during this storage period, it is possible that some incipient stresses in the wood may disappear, which would result in reducing cracking in the sawn material. Teak is said to give less trouble after the logs are left for about a year in the forest after felling. Experiments in this connection with other species are in progress.

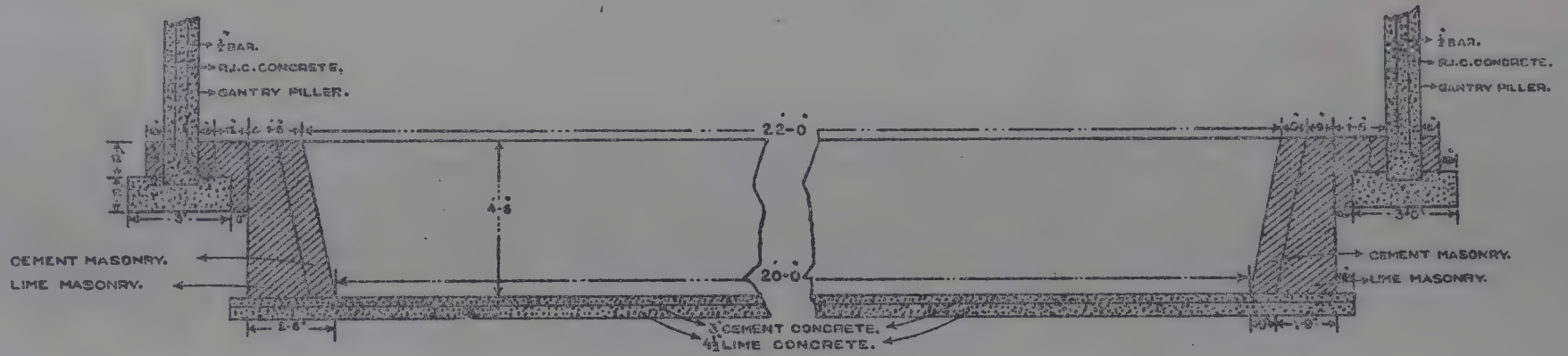
So much for seasoning in the log. There are, however, occasions when it is necessary to store logs, perhaps for a year or more, before they can be converted. What, then, is the best way to keep these logs in good condition and as free as possible from cracking, splitting, and attacks from insects and fungus ? One of the best and most practical ways to keep logs is to store them under water. Water submersion is not a seasoning process, it is merely a method of storage. When timber is kept under water it does not dry out, but certain constituents of the sap, such as the sugars, gums, and tannins, are leached out of the wood and replaced by water. This makes subsequent drying of the wood, after conversion, more easy, and reduces to a certain extent the liability of the wood to crack and split.

In addition, logs stored under water are immune from all the dangers of land storage. They cannot be attacked by borers (except marine borers in saltish and brackish waters), and they remain free from infection by fungi. Splitting and cracking are reduced to a minimum, and the logs are kept in good condition until required for conversion. They must, of course, be kept completely submerged, otherwise the portions exposed to the air will dry out, crack, and rot. The only real enemy to logs in under-water storage is the marine borer. The danger is present only in brackish or salt water, and if such pests are prevalent, they can do considerable damage even to large logs. Fresh water storage is, therefore, to be preferred, and it is equally necessary that the water should either be running or frequently changed. Storage in stagnant water may lead to deterioration of the wood due to the fermentation of leached-out sugars and the resultant acid products of fermentation. It is interesting to mention that of the thousands of logs stored in the log ponds of the Forest Research Institute at Dehra Dun during the past 16 years, there has never been a single instance of a log having deteriorated during its period of submersion, and some have been stored under water for over 10 years. The value of a good log pond, therefore, cannot be over-emphasised and with certain species, under-water storage is an absolute necessity. Logs of *Terminalia tomentosa* (laurel), for example, have been known to split so badly after a few weeks exposure to the sun, as to render them quite useless, and it is the same with many other species. If such logs had been stored under water, they would have come to the sawmill is an almost perfect condition.

Plate I



The log pond at the Forest Research Institute. This pond holds about 300 average size logs.



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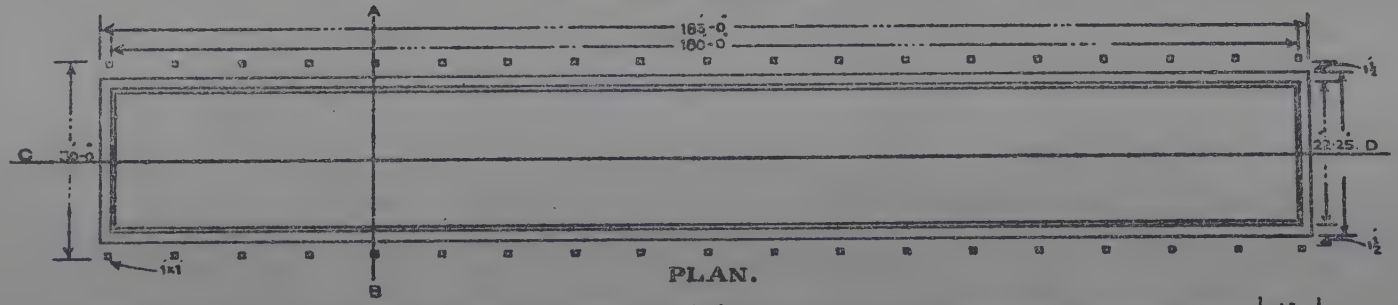
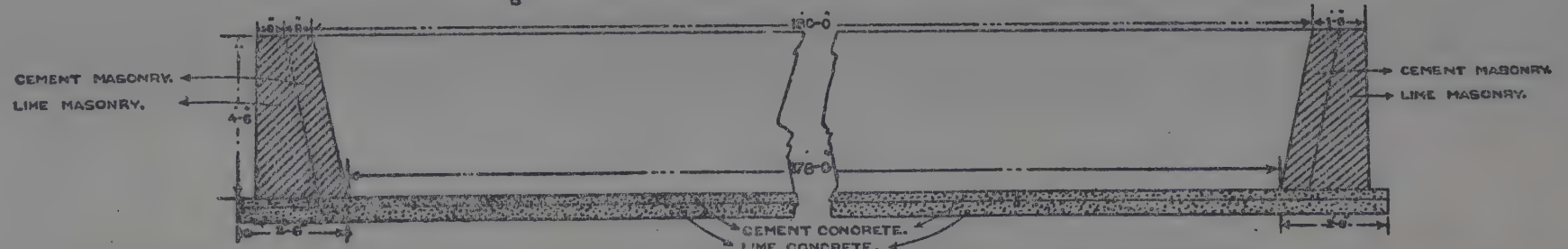


PLAN.



CROSS SECTION ON C.D.

F. R. I. Debra Dun.

Detail drawing of a log pond found suitable for Indian conditions.

No.889

DRAWN BY.

Users of miscellaneous hardwoods in India are, therefore, strongly advised to consider the advisability of making a log storage pond, if compelled, as most saw-millers are, to hold stocks of logs for any length of time. The initial expense may seem large and unnecessary, but the returns, in the saving of wood, which would otherwise have to be discarded, will more than compensate them for their first expenditure.

In the event of a log pond not being available, logs should always be provided, so far as possible, with some sort of shade or shelter. They can, for instance, be stored under the shade of trees, or a covering of thatch, grass, or leaves can be spread over them. Anything, in fact, which keeps off the direct rays of the hot Indian sun is beneficial. In addition, if logs are to remain in one place for more than a few days, they should be raised off the ground to prevent damage from insects and white ants. All bark should be re noved except in the case of species which are very prone to surface-cracking. The removal of bark greatly lessens the chances of the logs being attacked by insects. To prevent or reduce cracking at the ends of logs, painting with a moisture-retarding composition is most beneficial, as it slows down the drying out of moisture. The best paint for the purpose is hardened gloss oil, filled with lime or barytes, but white lead paint or ordinary coal tar are also useful. When none of these materials are available, an end-coating of a plaster of cow dung and mud may be applied. Incidentally, the end drying of logs is one of the chief causes of loss of timber during conversion. It is, therefore, most important that some care should be taken to protect the ends of all logs stored on land.

Green conversion.

The above remarks refer to occasions when users have to hold logs in storage. It is very essential, however, to remember that early conversion is preferable to storage, and that the storage of logs, even under water, is not the ideal method but only the result of necessity. Extensive experiments on air-seasoning in different parts of India have proved conclusively that the time of conversion plays an important part in the success, or otherwise, of the seasoning process. In the case of refractory woods, it has been found that conversion in the rainy season gives the best results, as drying is then retarded, and several cool months intervene before the arrival of the very hot dry weather of early summer, when drying is very rapid.

In the case of soft, non-durable woods, the best results are obtained if such species are converted after the rainy season is over; the object in this case being to dry out the timber as quickly as possible after conversion

In this connection, a study of the *Manual on the air seasoning of Indian timbers,** by Dr. S.N. Kapur, Seasoning Officer at the Forest Research Institute, Dehra Dun, and of the Indian Forest Record (new series), Utilisation, Vol. 1, No. 8, *Notes on the Air Seasoning Characteristics of some Indian woods* by Kapur and Rehman, is instructive, and would be of value to all timber users. The proper season for conversion plays a far more important part in the final condition of seasoned wood than most people realize, and more attention should be paid to this very essential factor in conversion.

Girdling.

By the term "girdling" is meant the cutting of a ring near the base of a tree, the ring being about 6 inches wide and from one to two inches in depth, from which all traces of sapwood are removed. The object of girdling is to cut off the supply of soil moisture to the tree and thus to kill it. Sap passes up a tree through the sapwood only, and the removal of the sapwood in a circle round the tree effectively prevents the upper part of the tree from obtaining nourishment. In the exploitation of teak in Burma, girdling is the standard practice, the trees being left standing after girdling for two to three years, during which period the wood loses a considerable part of its moisture, with the result that the logs become floatable, and their transport by water is facilitated.

There is some evidence to show that the converted material from girdled trees is also less liable to cracking and splitting than that from trees felled without girdling. Previous experiments in India have shown that, in the case of a number of Indian hardwoods, girdled trees are very liable to insect attack, and in some species the wood gets so dry that the tree shatters when it is felled. Girdling, cannot, therefore, be adopted as a standard practice. There are, however, many species for which girdling for one to two years before felling is recommended. This practice is likely to be of service with those refractory hardwoods which are used in big sizes, either for constructional purposes or as railway sleepers, and which do not really have a chance of becoming properly seasoned before use. Girdling in such cases will reduce the moisture content of the wood in the standing tree, and will thus help in reducing cracking and splitting of the wood in subsequent use.

Experiments carried out recently at Dehra Dun on the girdling of standing trees of *Anogeissus latifolia* (axle-wood), *Terminalia tomentosa* (laurel) and *Eugenia jambolana* (*jaman*), indicate that different species respond differently to the process of girdling, and that the time of girdling has an important effect on the speed with which girdled trees die, this effect varying with species. For further information on the usefulness or otherwise of girdling for

* Now under revision.

any particular species, a reference should be made to the Forest Research Institute, Dehra Dun.

Seasoning in scantling form.

Recent experiments at Dehra Dun have shown that many of the highly refractory hardwood species that are prone to excessive cracking, splitting, warping and other defects in the form of thin boards, can with advantage be first air seasoned in the form of thick scantlings, and subsequently converted into thinner sizes. Success with this method has been attained with *Schima wallichii*, *Quercus lincata*, *Quercus lamellosa*, *Anogeissus latifolia* and other species. The time required for seasoning is certainly increased, but it is not incommensurate with the results obtained.

Salt seasoning.

Some highly refractory species, which are liable to excessive surface-cracking, behave a little better if the converted material is soaked for some time in a solution of common salt before it is stacked for air-seasoning. A certain amount of salt is absorbed by the surface layers, and this helps in maintaining a relative humidity of about 80 per cent on the outside of the piece of timber. This high humidity allows the diffusion of moisture from the interior, maintaining at the same time the surface layers of wood in a moist condition. This helps to prevent unequal shrinkage which results in cracking and splitting of the wood.

The experiments carried out at Dehra Dun have also shown that boiling timber in a salt solution, and allowing it to cool in the solution for 12 to 18 hours, is more effective than the mere soaking of the green wood in the solution. In the latter method, more salt is absorbed by the wood, and the results are much better. This method can be recommended for such purposes as the seasoning of large mallet heads of timbers like *bijasal*, *babul*, *sissoo* and other species which are rather liable to crack when used in large sizes unless they are very carefully seasoned.

In place of common salt, other hygroscopic substances can be used, such as calcium chloride, molasses and various sugars. Urea can also be used for this purpose with the additional advantage that, besides being non-corrosive, it does not cause the wood to "sweat" in humid climates. This soaking in chemicals is sometimes known as "Chemical Seasoning", and it is mentioned here because, under certain circumstances, it can be very effective. It is not, however, a procedure to be adopted in all cases.

CHAPTER II.

Air-Seasoning.

By far the most important factor connected with timber utilization in India is the proper seasoning of the woods used. This all-important matter has, unfortunately, been sadly neglected in India, with the result that many excellent timbers have been condemned as liable to crack, warp, swell or shrink, while Burma teak is upheld as a pattern. The truth of the matter is that the teak had probably been standing "girdled", *i.e.*, as a dead tree, for two or three years in the forest before it was felled, and had then taken two or more years to be floated down to Rangoon. There it was sold, and eventually found its way to India where it was converted and afterwards stacked for six months or so, with the result that the wood, when actually used, was in a more or less seasoned state. Other species are not girdled, and the majority are usually extracted from the forest in one working season, so that, when converted, they are still quite green, and consequently may crack excessively when exposed unprotected to the hot Indian sun and dry winds. Teak would behave in much the same manner if similary treated, and, as a matter of fact, green teak is not much better in this respect than many of the lesser known woods. It is, however, a fact that the shrinkage of teak is less than that of most other timbers, and as a result, the "working" or "moving" of teak, due to seasonal changes, is slight. This is one of the chief reasons for its popularity. Shrinkage varies with weight, and, weight for weight, teak heads the list of Indian woods in this respect. In addition, the natural "oiliness" of teak retards the absorption of moisture, and, as a result, when teak is exposed to fluctuating weather conditions, it takes longer to respond to these conditions than most other woods. Again, teak and several of the best-known Indian woods, except *sal*, are easy to air-season whereas most of the lesser known species are not always so amenable. This drawback has been one of the chief factors which has militated against the latter becoming popular amongst Indian timber users. The blame, however, does not always lie with the wood, but, more often than not, it is the timber merchant himself who has not given the wood a fair chance. The object of this Chapter is, therefore, to place before timber users, in simple language, a few practical directions for air-seasoning wood in India, and thereby enable them to use some of the lesser known Indian timbers, which may, in some cases, be far more suitable than those at present used for certain purposes, and at the same time may cost less and give greater satisfaction.

Simple instructions for air-seasoning in India.

In the main, there are two important points to be attended to in air-seasoning timber in India. These are :—

(*a*) The proper piling or stacking of the timber.

(*b*) The protection of the stack from the prevailing hot winds, the blazing Indian sun, and the rain.

(*a*) Piling timber for air-seasoning.

1. The foundation upon which the timber is to be stacked is the first matter of importance to attend to. Squared logs, beams, sleepers or scantlings may be used, but unless treated with some preservative, they soon rot in contact with the ground, or are attacked by white ants, the infection spreading later to the pile above.

Concrete or brick-work foundations are by far the most satisfactory. They may be put in as small pillars about 1 foot square in cross section and about 4 to 5 feet apart each way, and rising about one foot above the level of the ground. These masonry pillars protect the stack of timber against infection from soil organisms, fungi, and insects but do not afford sufficient immunity from white ants, for which purpose an anti-termite course is recommended. This consists of a thin sheet of galvanised iron, a little bigger in size then the cross section of the pillar, with edges bent downwards at about 45 degrees. This is interposed in the masonry work near the top of the pillar, with the bent down edges protruding all round. No white ant can pass this guard. Across the top of the small pillars, squared scantlings, say $5'' \times 7''$, or any other available size, should be laid parallel to the length of the stack. Old iron beams or rails are also very satisfactory for the purpose. These form the base upon which the timber will be stacked, and being merely a skeleton framework, allow a free circulation of air underneath the pile. On these base supports, cross scantlings of say, $2'' \times 2''$ or $3'' \times 3''$ section are placed, to serve as bases for the vertical lines of "crossers". If the stack is to be built under cover of a roof, the foundations should be level. If, however, the timber is to be piled in the open, then a slope of 1 in 10 should be allowed, in the direction of the length of the boards, to allow rain-water to run off.

The orientation of the stack foundations is also a matter of no small importance, as on this will depend the manner in which the timber will be piled. As a general rule, and especially in the case of refractory timbers, the end of the pile of seasoning timber should face the direction of the prevailing dry winds, or, in other words, the length of the pile should be in the same direction as the prevailing dry winds. The main force of the hot blast is

then met by the sides of the "crossers", and only one end of the planks is exposed to it. When seasoning non-refractory woods and light soft timbers such as *semul (Bombax malabaricum)*, *papita* (*Sterculia companulata*), etc., the piling should be done with the length of the crossers parallel to the direction of the prevailing dry winds, because with these timbers drying in the quickest possible time is required.

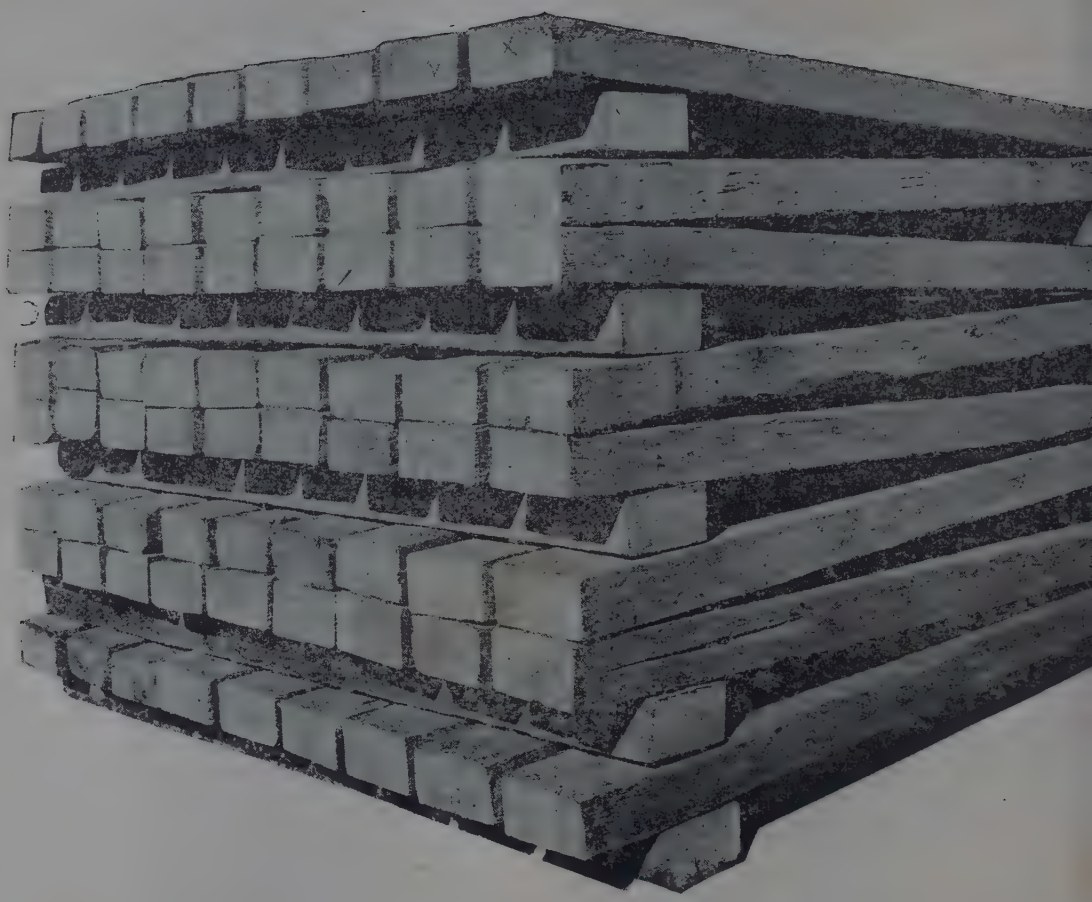
2. Having made the foundations and prepared the skeleton framework upon which the timber is to rest, nothing remains but to stack the timber which is to be seasoned. The first thing to do is to sort the planks or scantlings to their respective lengths. As a general rule, only pieces of the same length should be piled together. If, however, it is absolutely necessary to pile unequal lengths together, then the longest pieces should be sorted out and piled at the bottom of the stack, the next longest above them, and so on up the stack, with the shortest pieces at the top. Long pieces should not be ordinarily piled over shorter ones, otherwise bad twisting and warping are bound to result. Any long pieces projecting out from the stack should have their ends separately supported as shown in the photograph. The ends of the bottom pieces should, as nearly as possible, be directly above the foundation pillars, and in any case should not overlap the foundation framework by more than a few inches.

The width of a pile should not ordinarily exceed 5 feet, but, if it does, an open space 8" to 10" wide should be left in the middle of the pile, from top to bottom. This allows a good circulation of air in the centre of the pile and keeps the seasoning of all parts of the stack uniform. Between adjacent piles, there should be a free space of about $1\frac{1}{2}$ feet to 2 feet, to allow for a free circulation of air round the pile.

3 Having sorted the pieces according to lengths, the next step is to see that sufficient "crossers" are at hand to complete the pile. To those unacquainted with correct air-seasoning practice, it must here be explained exactly what crossers are and what function they perform. Put briefly, crossers are small battens, an inch or so square, and sufficiently long to stretch across the stack, which are placed in between the pieces of wood to be seasoned to separate them from each other and so form a space in between the pieces, which allows the air to circulate freely throughout the stack and come in contact with practically all parts of the pieces being seasoned. If planks are piled one on top of another with nothing in betweeu them, circulation of air would be impossible, and the surfaces of the planks lying against each other would remain damp, while other surfaces exposed to the air would be drying rapidly. This unequal drying would result in spliting, surface cracking, and warping of the timber,

Plate III (Upper)

Plate III (Lower)



A pile of railway sleepers stacked for air-seasoning in the 1 and 9 n

and would also increase the liability of mould growth and fungus development on the damp patches between the closely piled wood.

It will be seen, therefore, that crossers play an active part in air-seasoning operations, and their preparation must not be neglected. They should be sawn from sound timber and should be as dry as possible. They should also be of uniform thickness, the best size being approximately 1" × 1½". A width of 1½" × 1" thick crossers gives a more stable piling than if 1" × 1" crossers are used. Formerly it was the practice to use small crossers for thin boards and bigger crossers for larger sized stock, but taken all round, 1" × 1½" crossers are the most suitable for all ordinary work. When piling commences, the crossers are placed, at intervals of not more than 4 feet, at right angles to the pieces to be seasoned. If any particular wood is very liable to twist or warp, they should be placed at lesser intervals, say 2 feet apart. The same should be done in the case of all boards of less than 1" in thickness, as these are more liable to warp than thicker stock. The second layer of crossers must be placed *exactly* above the first layer, with a layer of planks in between, and so on up the pile, so that, when the ends of the crossers are seen from the side of the pile, they are all in straight vertical lines from the bottom of the pile to the top. The two end lines of crossers should always be as near the ends of the planks as possible. This prevents the ends of the planks from splitting to a certain extent, and also from warping. It is not a bad practice to treat crossers with a preservative if they are of a perishable type of wood. This increases their life considerably and results in a stock of sound crossers being always available.

4. Everything now being ready, nothing remains but the actual piling of the timber, which, in itself, is not a difficult operation. Timber can, of course, be piled vertically or horizontally but these instructions deal only with horizontal piling; vertical piling being an entirely different business, and one used in special circumstances only and not recommended as a general rule.

The piling commences, then, with a layer of the pieces to be seasoned being laid on the skeleton framework, the top of which is about 20 inches from the ground. Next above these comes a layer of crossers, then another layer of planks, and so on to the top of the pile. There is nothing difficult about this, the chief points to remember being to pile the longest planks at the bottom and to keep the sides, and at least one end of the planks, in a true vertical plane. If the planks are not all of one length, then the other end is bound to be irregular, the longest planks being at the bottom and the shortest ones at the top. In the same way as already mentioned, the crossers should be in a vertical line, one

above the other. It is important that adjoining planks should not actually touch each other. A small space should be left, to allow free access of air to the sides of the planks, as well as to the top and bottom faces.

This then is all that is required in the proper piling of timber for seasoning. There is nothing difficult about it and it requires little, if any, more trouble than piling planks haphazard one on top of the other, a practice frequently seen, it is sad to relate, throughout the length and breadth of India. Yet note the difference in the results. In the one case, half the stock is often lost, either through rot, staining or white ant attack from being in contact with the ground, or from splitting and twisting. In the other case, and with very little extra expense or trouble, the timber dries out evenly and quickly, the loss due to contact with the ground is absent altogether, while cracking and warping are reduced to a minimum, and the owner has a fine stack of well seasoned wood.

(*b*) PROTECTION OF THE STACK FROM HOT WINDS AND SUN.

We now come to the second factor of importance, namely, the protection of the stack from the hot dry prevailing winds, the blazing Indian sun and the rain; the first two being the chief causes of too rapid drying of wood and consequent splitting and cracking. It is quite evident that a pile of timber is subjected to a terrific ordeal if the scorching Indian sun is allowed to beat down on it day in and day out. In the same way, the hot desiccating winds, which blow for weeks on end in most parts of India, have a drying power equal to, if not greater than, the sun.

It is obvious, therefore, that some kind of protection must be given to the stacked timber, especially when dealing with woods which are very liable to cracking and splitting. The next question is to decide what kind of protection will be the best, bearing in mind that it must be effective for the class of timber to be dealt with and, at the same time, it must be as cheap as possible. Mr. C. V. Sweet, late Seasoning Officer at Dehra Dun, has dealt with this question in detail in his Indian Forest Record, Vol. IX, Part V, page 65, published in 1922, by the Superintendent, Government Printing, India. He divides the Indian woods into three classes :—

(1) Woods which are very liable to crack, split, and warp, called refractory woods.

(2) Woods which are only moderately liable to crack, split, and warp, called medium refractory woods.

(3) Woods which are capable of withstanding rapid seasoning, or are particularly liable to staining, mould, and decay during seasoning, called non-refractory woods.

In order to obtain the best results when air-seasoning timbers falling under one of these heads, he has proposed a different type of shed for each class, and, as he has put the whole matter briefly and with great clearness, I cannot do better than repeat what he says. He first explains that the amount and kinds of shelter required for successful air seasoning vary with the characteristics of the wood and climatic conditions of the locality. Woods which have a tendency to crack and split are those which suffer most from rapid seasoning, and, therefore, require means of reducing the rate of drying by maintaining a relatively high humidity in the air surrounding them. Other woods, such as *semul* (*Bombax malabaricum*) or *salai* (*Boswellia serrata*), have a tendency to discolour and decay, and must be treated quite differently from refractory woods. In this case, the surface of the wood must be permitted to dry as quickly as possible, so that fungus and mould may not be able to develop. The only protection needed in this case is from rain. The sun and wind should be given full opportunity to accomplish drying as quickly as possible. In the same way, woods of medium refractoriness must be given a half and half treatment, so that drying is neither too slow nor too rapid. The following are three types of sheds recommended for these three different classes of timbers.—

1. *Seasoning sheds for refractory timbers.*

It is obviously impossible to lay down a rigid specification for a seasoning shed to suit all requirements, as the climate, the species to be seasoned, and the size and permanency or otherwise of the project, all have a bearing on the most suitable type of shed to instal. However, the essentials for a suitable seasoning shed for refractory woods, especially in dry regions, are as follows:—

(*a*) A light water-tight roof to keep off the sun and rain.

(*b*) Shelter at the sides exposed to sun and drying winds.

(*c*) Ventilation under the roof and below the piles, for admitting fresh air and for getting rid of the moisture evaporated from the wood.

The sheds best adapted to meet the above requirements are long narrow buildings. The loading and unloading can be done either from a central passage down the middle of the shed or from the two sides. If loading from the centre is proposed, the shed should be 40 to 50 feet wide, and the timber should be piled 16 to 18 feet deep on either side of the central passage. The side walls should be perfectly immovable, and may be made of any tight material such as heavy thatch, mud, bamboo and mud plaster, wood or brick, the essential point being that the walls must protect the timber from sun and wind and must not extend right up to the roof or right down to the ground ; an opening $1\frac{1}{2}$ to $2\frac{1}{2}$ feet

wide being left at the top as well as at the bottom, to allow a free circulation of air through the piles.

If loading from the sides is preferred, the side walls must be movable, and the width of the shed should not be more than 30 to 40 feet. Walls consisting of a series of swinging or sliding doors made of wood or thatch. provide a good permanent type of construction, but more temporary and cheaper walls may be made by closing the sides, except for the space under the roof and above the ground, with boards, standing on end, side by side, and secured in a slot or by a collar. This arrangement involves no great expense, as the boards can be taken from discarded stock or cut from some cheap species. All or any of the boards should be easily removable for loading or unloading, and, if necessary, a board here and there can be removed to allow a free circulation of air if the condition of the stack requires it.

The next important thing is to know which woods are refractory and which are not. From experiments carried out by the Seasoning Section of the Forest Research Institute, the following species have been classed as refractory timbers, and timber merchants and others are advised to use sheds such as that described above, when seasoning these species, particulary in a dry climate:—

Aegle marmelos (bael).
Aglaia odoratissima.
Altingia excelsa (jutili).
Anogeissus acuminata (yon).
Anogeissus latifolia (axle-wood)
Anogeissus pendula (kardahi).
Bassia latifolia (mahua).
Bassia longifolia (mahua).
Bursera serrata (Indian red pear).
Careya arborea (kumbi).
Carallia integerrima.
Carapa moluccensis (pussur).
Cassia fistula (rajbrikh).
Chloroxylon swietenia (East Indian satinwood).
Cleistanthus collinus (garrar).
Diospyros melanoxylon (tendu).
Drimycarpus racemosus (telsur).
Eucalyptus eugenioides.
Eugenia gardneri (jaman).
Eugenia jambolona (jaman).

Eugenia operculata (jaman).
Gluta travancorica (gluta).
Hardwickia binata (anjan).
Heritiera minor (sundri).
Hopea parviflora (hopea).
Hopea wightiana (hopea).
Lagerstroemia lanceolata (benteak).
Lagerstroemia parviflora (lendi).
Ougeinia dalbergioides (sandan).
Phyllanthus emblica (amla).
Planchonia andamanica (red *bombway*).
Quercus lamellosa (Indian oak).
Quercus lineata (Indian oak).
Shorea robusta (sal).
Soymida febrifuga (rohin).
Terminalia paniculata (kindal).
Terminalia tomentosa (laurel).
Xylia xylocarpa (irul).

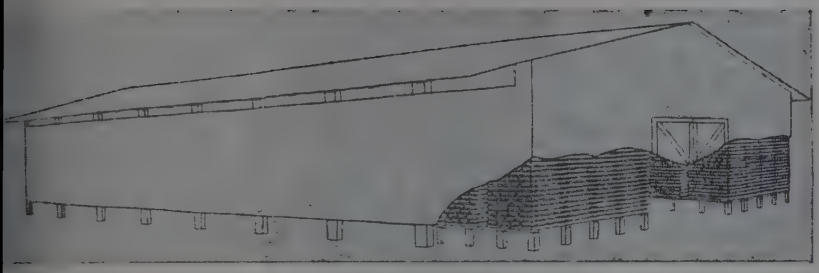
2. *Seasoning sheds for medium refractory timbers.*

The seasoning of woods, which are only moderately liable to crack and warp, can be carried out more quickly than is the case with refractory timbers. The type of shed most suitable for these timbers is practically a half section of the first shed described above, *i.e.*, one side is permanently closed* (except under the roof and above ground), while the other is left open, with a roof sufficiently overhanging to protect the piles from rain. This type of shed should be left open on the north side, unless otherwise shaded, so that the exposed side will usually be in the shade. The roof, both for this type of shed and for the other type described above, may be of any material which is weatherproof, such as thatch, tiles, wood or iron. In all cases, however, it is important that the roof should overhang the sides of the shed by at least 3 feet, so as to protect the space left for ventilation between the roof and the walls from driving rain.

The following timbers may be classed as medium refractory woods and should be seasoned in sheds similar to that described above :—

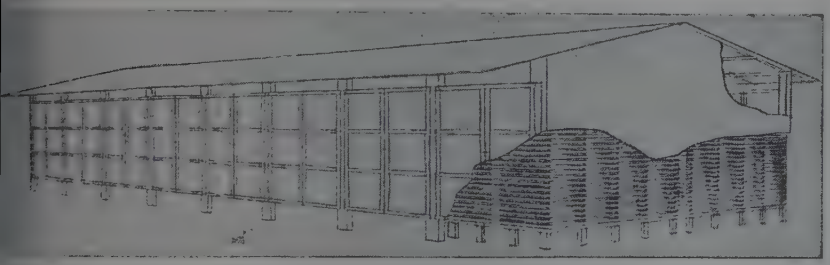
Acacia arabica (babul).
Adina cordifolia (haldu).
Albizzia lebbek (kokko).
Albizzia lucida.

Albizzia odoratissima (black *siris*).
Albizzia procera (white *siris*).
Albizzia stipulata.
Artocarpus chaplasha (*chaplash*).
Artocarpus lakoocha (*lakooch*).
Artocarpus hirsuta (*aini*).
Boehmeria rugulosa.
Calophyllum species (*poon*).
Castanopsis sp. (Indian chestnut).
Cedrela toona (*toon*).
Dalbergia latifolia (Indian rosewood).
Dalbergia sissoo (*sissoo*).
Dillenia pentagyna (*aggai*).
Dipterocarpus species (*gurjun*).
Dichopsis elliptica (*pali*).
Dichopsis polyantha (*tali*).
Dysoxylum glandulosum (white cedar).
Fraxinus floribunda (Himalayan ash).
Garuga pinnata (*kharpat*).
Gmelina arborea (*gamari*).
Grewia tiliaefolia (*dhaman*).
Hardwickia pinnata (*piney*).
Holarrhena antidysenterica.
Holoptelea integrifolia (*kanju*).
Hopea odorata (*hopea*).
Hymenodictyon excelsum (*kuthan*).
Juglans regia (walnut).
Lagerstroemia flos-reginae (*jarul*).
Machilus sp. (*kawala*).
Melia azedarach (*neem*).
Odina wodier (*jhingan*).
Parrotia jacquemontiana (*parrotia*).
Pterocarpus dalbergioides (*padauk*).
Pterocarpus marsupium (*bijasal*).
Pterospermum acerifolium.
Saccopetalum tomentosum (*hoom*).
Sageraea elliptica (*chooi*).
Schima wallichii (needlewood).
Schrebera swietenioides.
Stephegyne parvifolia (*kaim*).



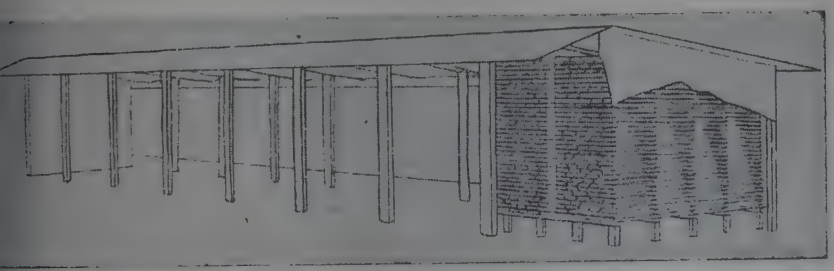
AIR SEASONING SHED TYPE 1a.

With central passage for loading & unloading. Suitable for highly refractory woods in dry climates.



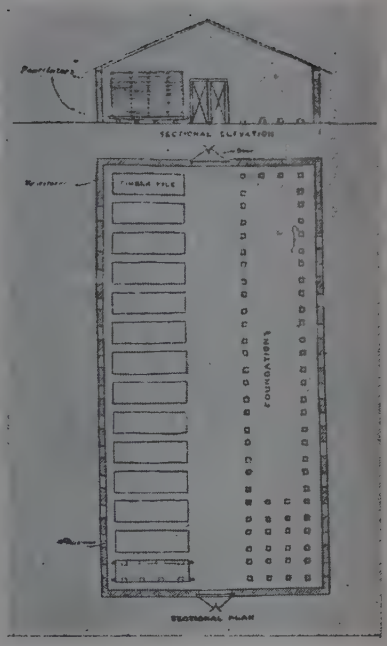
AIR SEASONING SHED TYPE 1b.

With removable sides for loading & unloading. Suitable for highly refractory woods in dry climates.

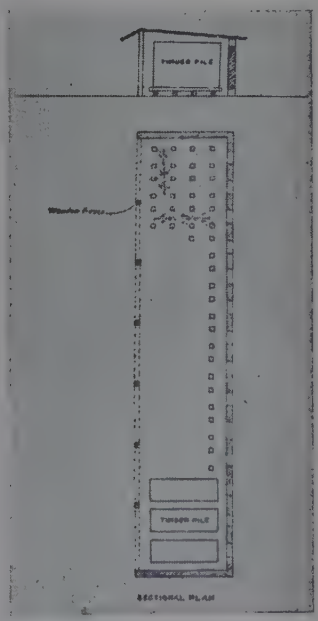


AIR SEASONING SHED TYPE 2.

Open on North side.
Suitable for medium refractory woods in moderately dry climates.



AIR SEASONING SHED TYPE 1



AIR SEASONING SHED TYPE 2

TYPES OF AIR-SEASONING SHEDS.

hotograph showing vertical method of stacking non-refractory timber fo
rapid drying to prevent mould growth and discolouration.

Stereospermum chelonoides (*padri*).
Stereospermum suaveolens (*parari*).
Stereospermum xylocarpum.
Tectona grandis (teak).
Terminalia arjuna (*arjun*).
Terminalia belerica (*bahera*).
Terminalia bialata (white *chuglum*).
Terminalia manii (black *chuglam*).
Terminalia myriocarpa (*hollock*).
Terminalia procera (*badam*).

3. Seasoning sheds for non-refractory woods.

We now come to the last type of shed, namely, that designed for woods which are capable of withstanding rapid seasoning, or are particularly liable to staining, mould, and decay during seasoning. The essentials in this case are almost the opposite to those for refractory woods. The chief thing is to protect the timber from rain, but at the same time to allow as free a circulation of air as possible through the piles. This is not difficult, and the type of shed required is simple. All that is necessary is that the timber should be piled under a good weatherproof roof, in such a manner that all sides are exposed to the air. It is also advisable, in this case, to place the piles so that their length is at right angles to the prevailing winds. The crossers between each layer of planks will then be end-on to the prevailing wind, and the air-currents can pass straight through the piles without much resistance. This will result in very rapid drying of the surface of the planks, thereby preventing attack by fungi, which cause rot and stain, as such fungi must have moisture to be able to establish themselves. In the case of such timbers as *semul* (*Bombax malabaricum*) and *salai* (*Boswellia serrata*), which are very liable to the rapid formation of mould and to staining, it is a good plan first to stand the planks up on end against a horizontal support for a week or two after conversion. This ensures still more rapid drying, but it should not be continued too long, otherwise the planks are apt to warp. After this short period of "vertical seasoning", the planks should be piled horizontally as already described. The timbers falling under this third category are the following :—

Abies pindrow (Himalayan silver fir).
Acrocarpus fraxinifolius (*mundani*).
**Alstonia scholaris* (*shaitan* wood).
**Anthocephalus cadamba* (*kadam*).

* These timbers are very liable to stain, mould and rot.

**Bombax insigne* (*semul*).
**Bombax malabaricum* (*semul*).
**Boswellia serrata* (*salai*).
Canarium euphyllum (white *dhup*).
Cedrus deodara (*deodar*).
**Cullenia excelsa* (*karani*).
Duabanga sonneratioides (*lampati*)
Ficus asperrima.
Litsaea polyantha.
Michelia champaca (*champak*).
Mangifera indica (mango).
Morus alba (mulberry).
Parishia insignis (red *dhup*).
Picea morinda (Himalayan spruce).
Pinus excelsa (*kail*).
Pinus longifolia (*chir*).
**Sideroxylon longepetiolatum* (*lambapatti*).
**Sterculia campanulata* (*papita*).
**Sterculia urens* (*katira*).
**Sterculia villosa* (*udali*).
**Tetrameles nudiflora* (*maina*).
**Trewia nudiflora* (*gutel*).
**Vateria indica* (*vellapiney*).

The three lists given above do not cover all Indian woods, but only those on which experiments have been carried out with a view to classifying them into their respective categories. Timber users who intend seasoning timbers other than those included in these lists, would be well advised to obtain the latest information regarding such woods from the Forest Research Institute, before they start seasoning them.

Stacking of railway sleepers.

The usual method adopted for stacking railway sleepers for air seasoning is the "1 and 9" method. This is illustrated in plate VI. In case of refractory woods, when the "1 and 9". method would result in too rapid drying, and conseqent cracking, the common practice is to pile them in the "close crib" manner. This simply consists of making a solid stack of sleepers.

* These timbers are very liable to stain, mould and rot.

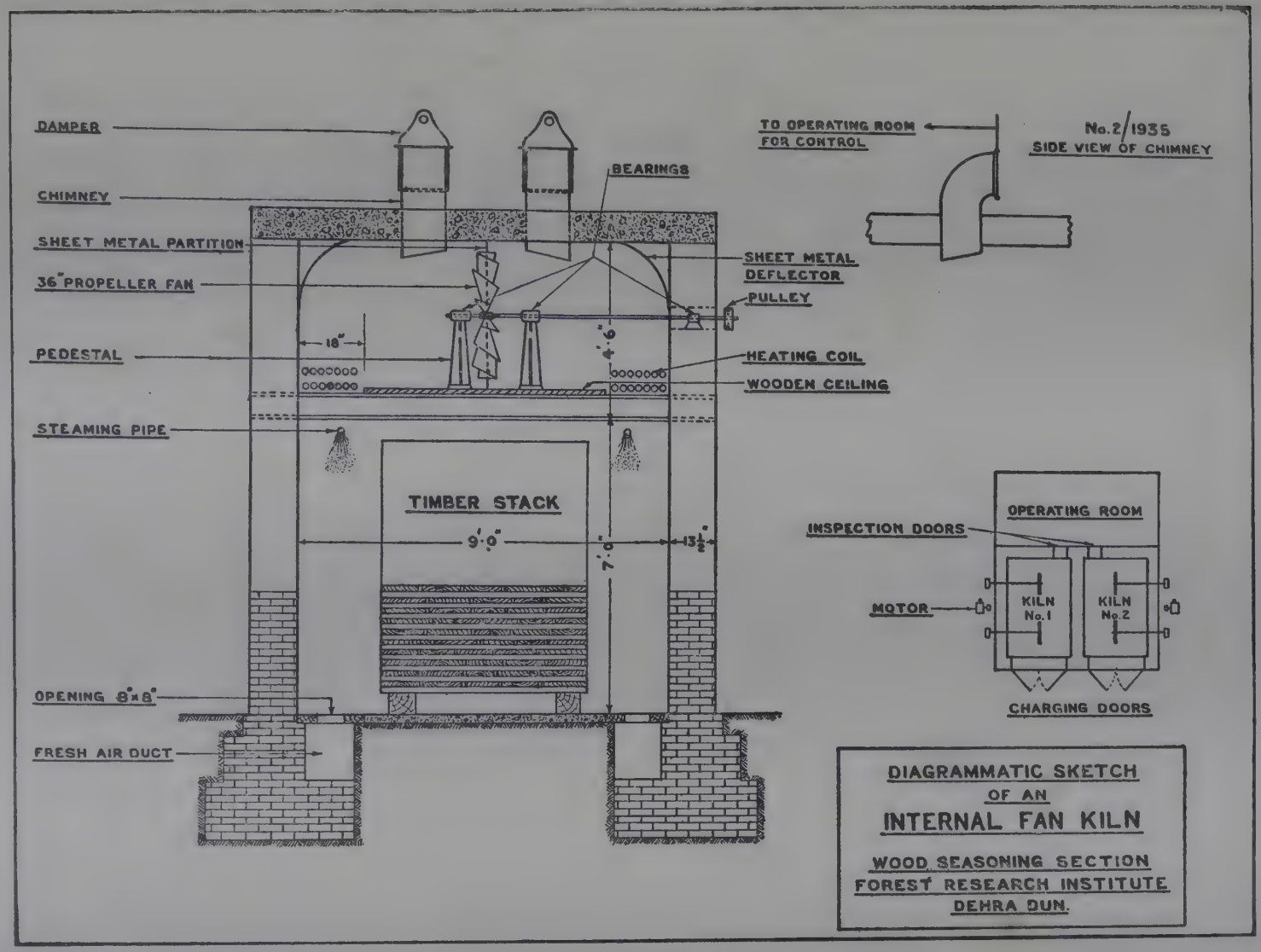

DAMPER
CHIMNEY
SHEET METAL PARTITION
36" PROPELLER FAN
PEDESTAL
STEAMING PIPE
OPENING 8"×8"
FRESH AIR DUCT
BEARINGS
SHEET METAL DEFLECTOR
PULLEY
HEATING COIL
WOODEN CEILING
18"
4'·6"
TIMBER STACK
9'·0"
13½"
7'·0"
TO OPERATING ROOM FOR CONTROL
No. 2/1935
SIDE VIEW OF CHIMNEY
OPERATING ROOM
INSPECTION DOORS
MOTOR
KILN No. 1
KILN No. 2
CHARGING DOORS
DIAGRAMMATIC SKETCH
OF AN
INTERNAL FAN KILN
WOOD SEASONING SECTION
FOREST RESEARCH INSTITUTE
DEHRA DUN.

Plate VII.

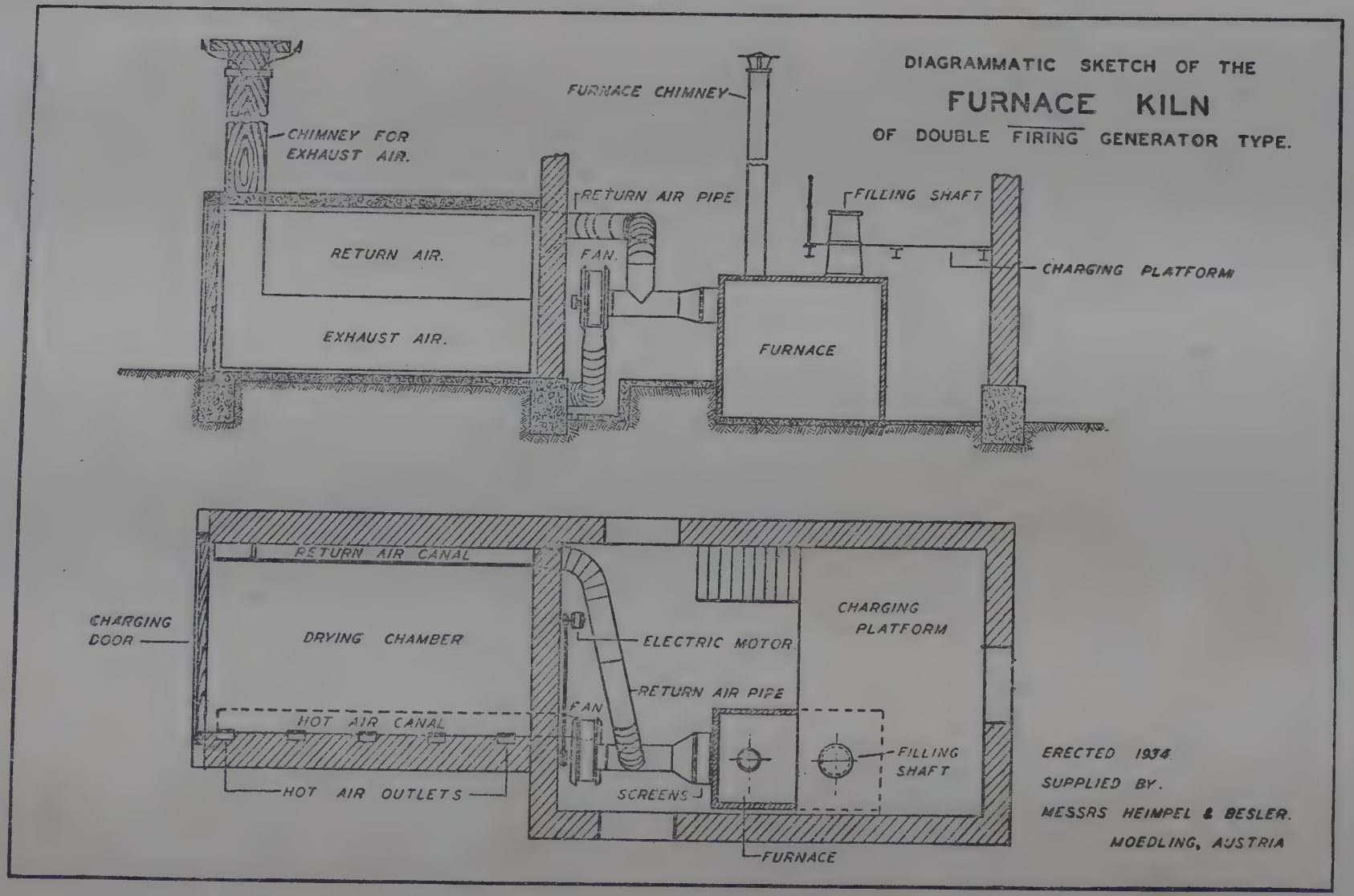

DIAGRAMMATIC SKETCH OF THE
FURNACE KILN
OF DOUBLE FIRING GENERATOR TYPE.
FURNACE CHIMNEY
CHIMNEY FOR EXHAUST AIR.
RETURN AIR PIPE
FILLING SHAFT
RETURN AIR.
FAN.
CHARGING PLATFORM
EXHAUST AIR.
FURNACE
RETURN AIR CANAL
CHARGING DOOR
DRYING CHAMBER
ELECTRIC MOTOR
CHARGING PLATFORM
RETURN AIR PIPE
FAN
HOT AIR CANAL
FILLING SHAFT
HOT AIR OUTLETS
SCREENS
FURNACE
ERECTED 1934.
SUPPLIED BY.
MESSRS HEIMPEL & BESLER.
MOEDLING, AUSTRIA

Plate VIII.

CHAPTER III.

Kiln Drying of Wood.

A few words will not be out of place to explain what is meant by the kiln drying of wood, or, as it is more usually called, kiln seasoning.

When wood dries under ordinary air-seasoning conditions, the moisture contained in the various elements of which wood is composed, is evaporated off by the heat of the surrounding air, the rate of drying depending, also, on the atmospheric humidity and circulation of air. In the dry summer months, when the temperature is high and the humidity low, drying is very rapid, in fact too rapid for many of the indigenous hardwoods which are rather susceptible to surface cracking and splitting, and consequently require protection against too rapid drying conditions. During cold winter nights, on the other hand, when the temperature is low and the humidity high, the rate of drying of wood is so low as to be practically negligible. During the wet monsoon months, also, the rate of drying is considerably slackened on account of the prevailing high atmospheric humidity. Taking everything together, therefore, it is only during a fraction of the total time required for the complete air-seasoning of a piece of wood that any drying actually takes place.

Fundamentally, the kiln drying of wood is based on exactly the same principles as the air-drying process, except that the conditions of drying, namely the temperature, humidity and circulation of air, are maintained during the process at a level at which wood will dry at a maximum rate without suffering damage to any appreciable extent. In kiln drying, higher temperatures are used than those obtainable in air-seasoning. This accelerates the process of drying, and means a considerable saving of time. Roughly speaking, in kiln seasoning, it is possible to reduce the period of drying to about one-twelfth to one-twentieth of that normally required for air-seasoning the same timber. With kiln drying it is also possible to dry wood to any desired low moisture content, and since the conditions of drying are always under control, the quality of the dried material is usually better than in air-seasoning, while seasoning losses from insect and fungus attack, etc., are kept down.

For many years progress of commercial kiln drying of wood in India was slow, chiefly on account of the fact that the cost of an installation, as well as the cost of operating kilns, was beyond the means of most small scale manufacturers. As most of the wood-working industries in this country are run on a small scale, attempts have been made at Dehra Dun to simplify kiln designs, as well as the processes of drying, to such an extent as to bring

them within the reach of the normal small scale furniture maker in India. It is gratifying to be able to record that the Seasoning Section at the Forest Research Institute at Dehra Dun, has succeeded in this aim, and a large number of small kiln installations are now successfully running in different parts of the country. A new process of kiln drying has been developed, which is much simpler to operate than the old process. It requires much less steam and does not necessitate continuous day and night operation. Kiln design has also been simplified, and a kiln with a charging capacity of about 250 cubic feet of sawn timber can be erected complete (excluding the steam boiler) at a cost of less than Rs. 2,500. In a kiln of this type, working during day time only, about 5,000 c. ft. of sawn timber in the form of one inch boards of a medium refractory hardwood can be dried in a year. The cost of drying depends upon many factors, namely the cost of fuel and electric current, the supervision and operating charges, the output from the kiln, etc. It may vary from annas 4 to 8 per cubic foot for drying one inch thick boards of timbers like *sissoo* or teak. The drying costs for other thicknesses upto 3 inches, would vary approximately in the same proportion.

For large scale operations, the kiln drying of wood is certainly more economical than air-seasoning. This is evident from the widespread use of commercial seasoning kilns in the United States of America and from their increasing popularity in European countries. In the last few years many progressive timber firms in India have installed batteries of seasoning kilns, chiefly for the drying of packing case woods. Installations for this purpose are now to be found in Assam, Bengal, Bombay and Malabar, and many new kiln installations are being planned. A list of kilns in India will be found in appendix IV. The cost of seasoning half inch boards of a light hardwood like *semul* in a large sized installation for drying box shooks is calculated to be between six pies and one anna per cubic foot.

The diagrammatic sketch on the opposite page gives a good general idea of the design of an internal fan kiln suitable for the drying of both furniture timbers and packing case woods. Practically all the equipment necessary for building up a kiln of this sort can be obtained from any engineering firm in this country. Further details should be obtained from the Officer in Charge of the Seasoning Section at Dehra Dun.

In places where steam is not already available, and the cost of purchasing and running a steam boiler, solely for the sake of a small seasoning kiln, is considered to be too high, a simpler type of kiln, having its own furnace, can be installed. A furnace kiln can be of two types, one in which the combustion gases perform the actual drying of the wood and, therefore, come in contact with the timber to be dried. This is called a direct heating type. In

FURNACE HEATED VENEER DRYING KILN.

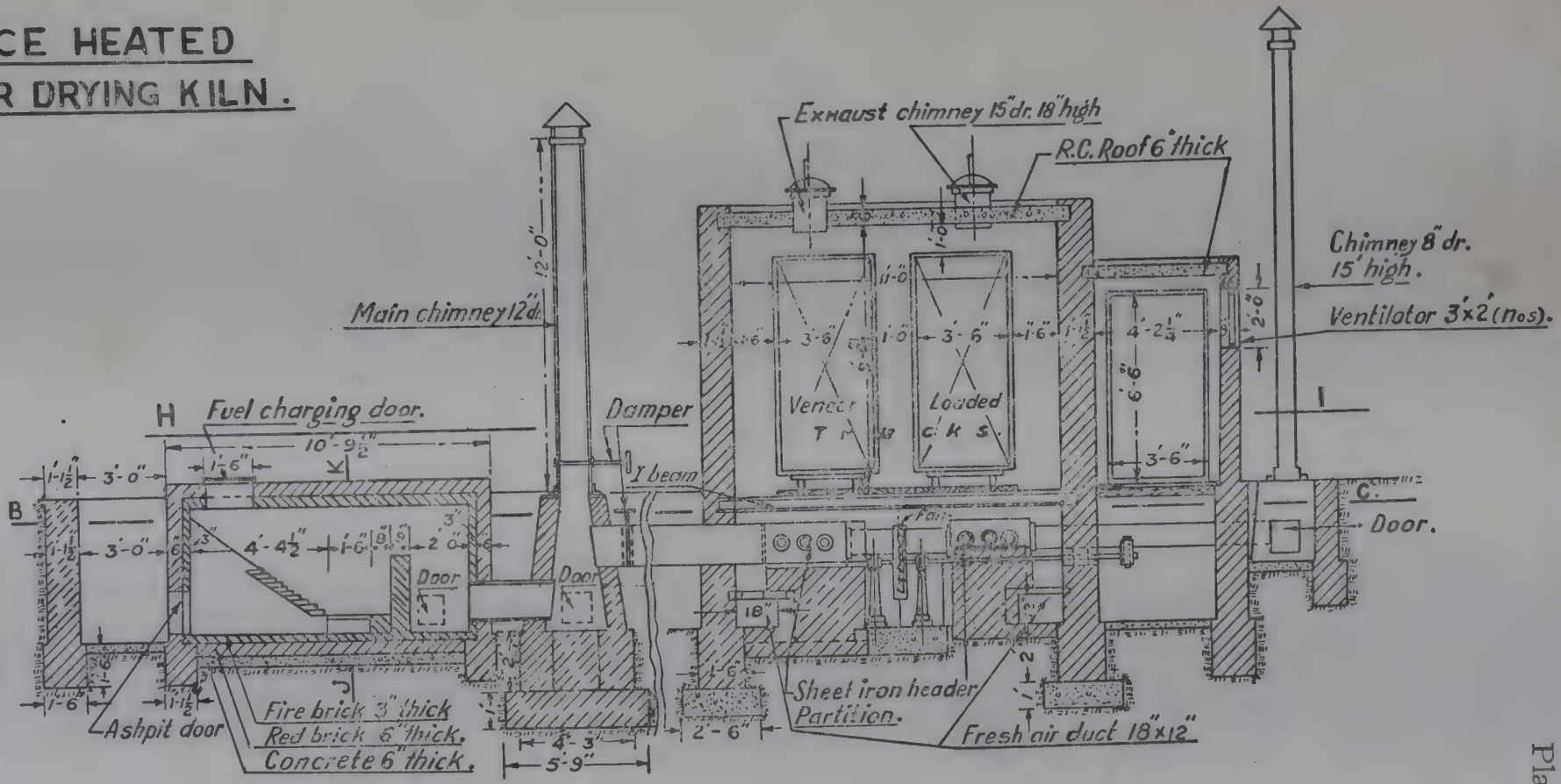


Plate IX.

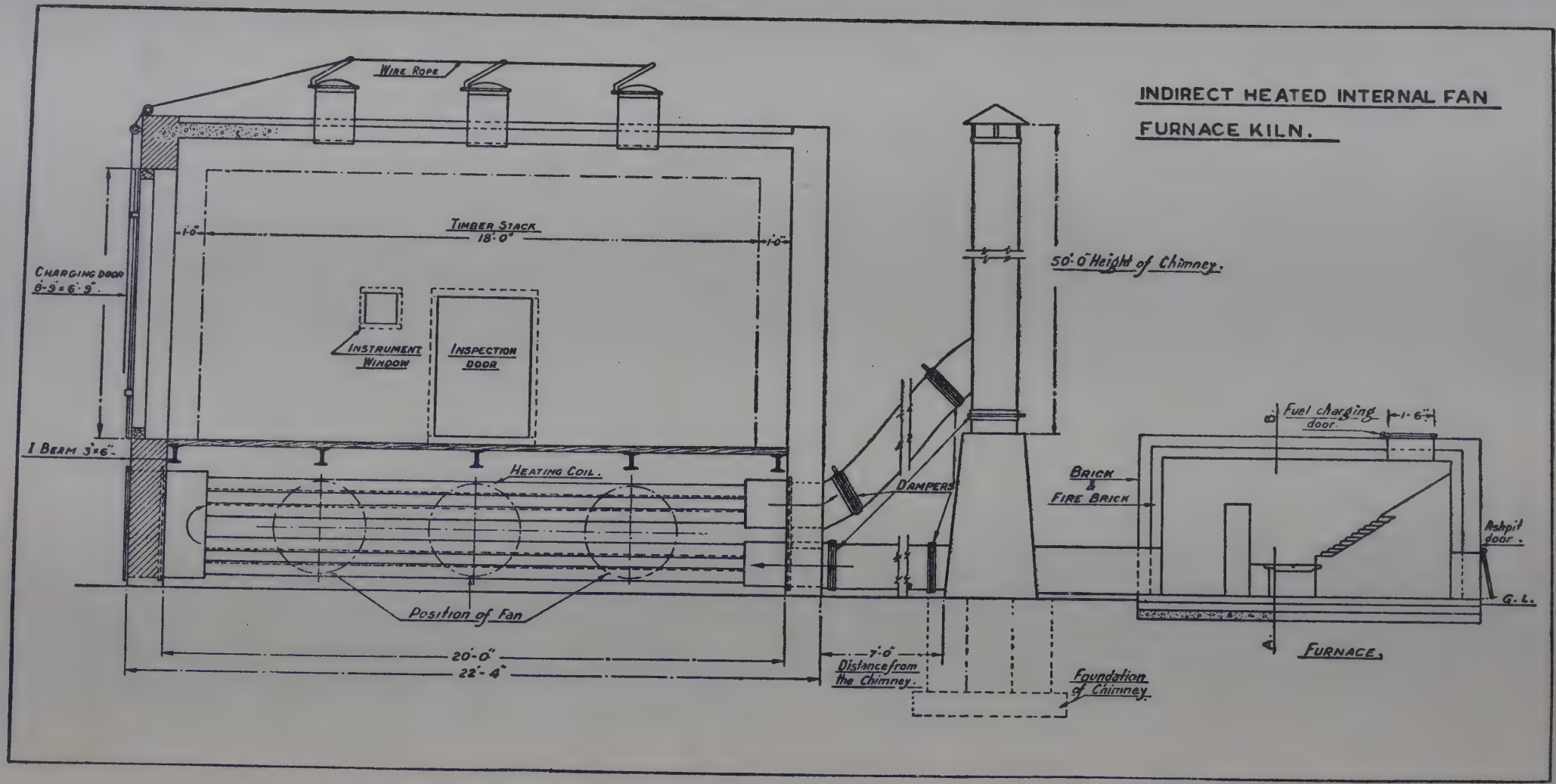

INDIRECT HEATED INTERNAL FAN
FURNACE KILN.
WIRE ROPE
TIMBER STACK
18'-0"
1'-0"
1'-0"
CHARGING DOOR
8'-9" x 6'-9"
INSTRUMENT WINDOW
INSPECTION DOOR
I BEAM 3" x 6"
HEATING COIL.
Position of Fan
20'-0"
22'-4"
50'-0" Height of Chimney.
DAMPERS
7'-0"
Distance from the Chimney.
Foundation of Chimney
8"
Fuel charging door.
1'-6"
BRICK & FIRE BRICK
Ashpit door.
G. L.
FURNACE.

Plate X

the second kind of furnace kiln, the hot combustion gases and smoke pass through sheet iron ducts, which are placed inside the kiln and which heat the air circulating inside the drier. This is called an indirect heating type. A furnace kiln of the direct heating type is diagrammatically illustrated on the opposite page. The kiln is equipped with its own furnace of a rather complicated design in which any wood waste can be burnt. The gases from the burning fuel undergo a second combustion, so as to get rid of the unburnt smoke and soot, and, after they are conditioned to the proper temperature and humidity by means of water sprays and the admission of fresh air, they are blown into the kiln by a centrifugal fan. This type of kiln has given very good result at Dehra Dun. The quality of the dried material is quite as good as that obtained in a steam-heated kiln, except for a slight surface-blackening of the wood. This is due to some unburnt smoke passing, at times, into the kiln. The discolouration is, however, purely superficial, and is easily removed by planing. The total cost of a kiln of this type including the building construction would not be more than Rs. 4,500, probably less.

This kiln is suitable for the seasoning of hardwoods for furniture manufacture. It can also be used for the seasoning of packing-case timbers, but the surface discolouration will have to be removed by planing, and this adds to the cost of manufacture. This type of kiln is not suitable for drying thick planks of very refractory hardwoods, such as *Terminalia tomentosa* (laurel) and *Eugenia jambolana (jaman)*, because it is not possible to raise the relative humidity of the circulating air above 90%. One inch boards of a timber like *Dalbergia sissoo (sissoo)* can be thoroughly seasoned from the green condition in 10 days, working the kiln 12 hours a day.

A furnace kiln of the indirect heating type is less costly to build and easier to operate. It has also the advantage over the direct heating type that the timber to be dried does not come in contact with smoke, and there is, therefore, no chance of surface blackening of timber during drying. Kilns of this type can be built with or without blower circulation as desired.

In order to introduce the use of seasoned wood for packing-cases, shuttle and bobbin making, the Forest Research Institute has recently improved and simplified the designs of indirect-heated furnace kilns, and different types of these kilns have been evolved, viz., the Indirect-heated internal-fan furnace kiln, the Indirect-heated, thermal circulation furnace kiln, the Hot air kiln and the Air condenser kiln. The internal-fan furnace kiln, the diagrammatic sketch of which is given in plate IX, is suitable for the rapid seasoning of packing-case timbers. It is not suitable for the seasoning of hardwoods because there is no arrangement for humidifying the air in the kiln. It has been found that half inch

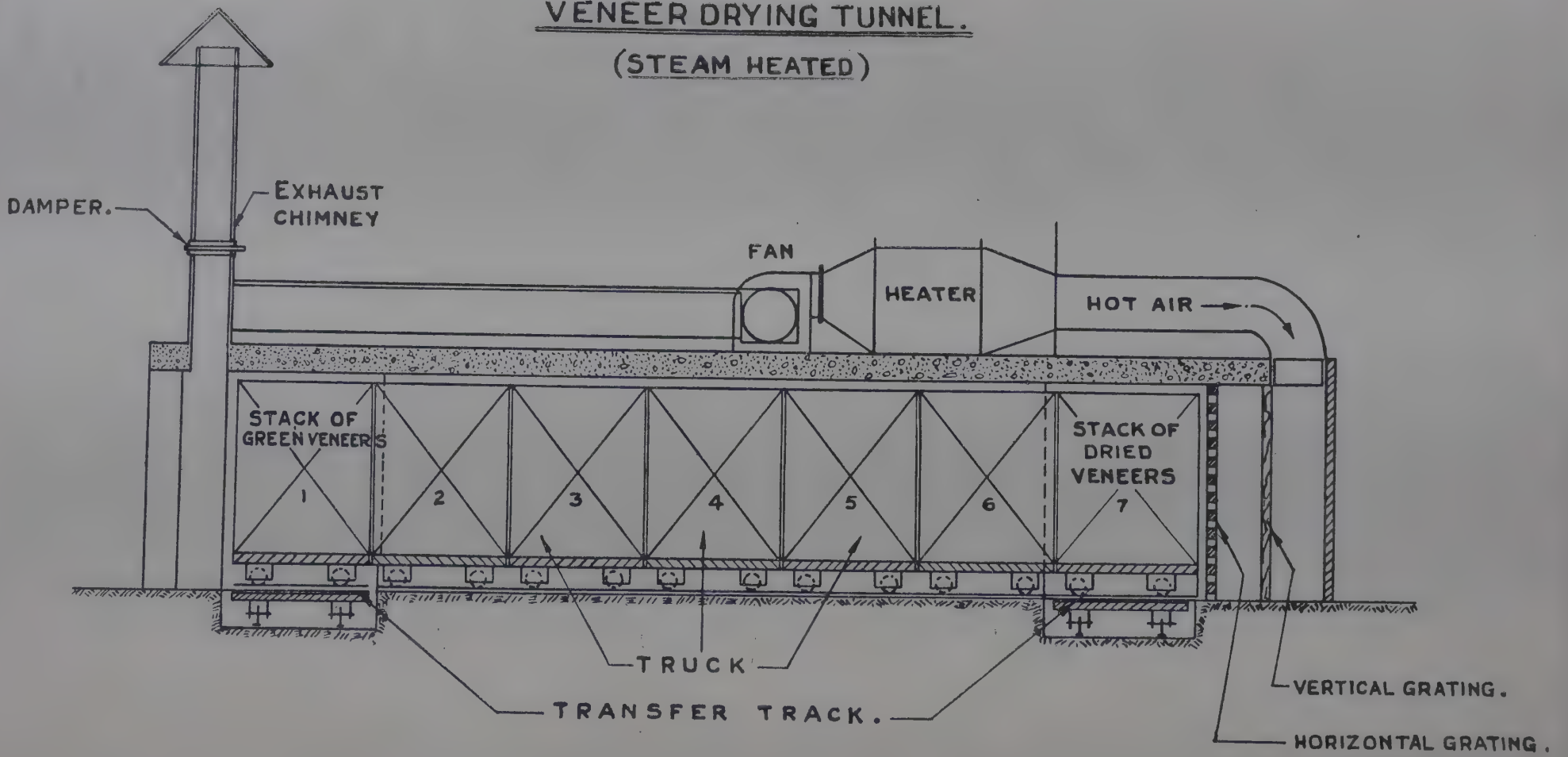
boards of a timber like *Bombax malabaricum (semul)* can be seasoned from the green condition to 10 per cent moisture content in 36 hours in a kiln of this type. The second type of kiln, namely the Indirect-heated thermal circulation furnace kiln is suitable for the slow drying of furniture woods. It cannot be used for drying timbers which are liable to severe cracking, but it can be used for the seasoning of packing-case timbers, also, if the circulation of air through the stack can be increased by stacking the timber in the kiln in the form of an inverted V, using thicker crossers than usual, and keeping the fresh air inlets and exhaust dampers of the kiln open. The third type of kiln, the Hot air kiln, is suitable for completing the seasoning of partially air-seasoned half-wroughts for the manufacture of shuttles, bobbins, picker arms, helves and tool handles. With this kiln, $2\frac{1}{2}'' \times 2\frac{1}{2}''$ blanks of refractory hardwoods, cut from planks which have been air seasoned for about two months, can be completely seasoned in about 15 days. A Hot air kiln, capable of holding 400 cu. ft. of wood in one charge, can be erected for about Rs. 1700, whereas an Indirect-heated internal-fan furnace-kiln, having a charging capacity of 300 cu. ft. of sawn material, can be erected for about Rs. 4000. The Air condenser kiln has been designed chiefly for the seasoning of cooperage woods, but certain observations recorded during the testing of different types of furnace kilns have indicated that this kiln can be used for the seasoning of packing case timbers also, by adopting proper devices for increasing the circulation of air through the stack of wood.

Proper seasoning of veneers, before gluing and manufacture into plywood, is very important, if satisfactory plywood is to be made. Green veneers can be air-seasoned or kiln-dried exactly like ordinary wood. The usual method in Europe and America, for the quick seasoning of veneers, is to dry them in long progressive dryers. These dryers are closed metal chambers 50 ft. to 100 ft. long, fitted with powerful fans for the rapid circulation of air, and with steam-heated pipes for raising the temperature of the air circulating inside the dryer. The green veneers are fed into one end of the drying chamber and slowly move towards the other end by means of endless belts, or between rollers fixed along the length of the dryer. The speed at which the veneers move can be controlled, but they are usually dried in the course of the few minutes which they take to travel from one end of the dryer to the other. Unfortunately progressive dryers are very costly, the pre-war price being more than Rs. 50,000.

Such dryers are, however, not essential for the quick seasoning of veneers, and it is possible to use certain other types of kilns which are much cheaper. The internal-fan steam-heated kiln, described in preceeding pages, can be successfully used for this purpose in plywood factories where steam is available. The

VENEER DRYING TUNNEL.

(STEAM HEATED)



advantage of this type of kiln is that it can be used both for the seasoning of sawn timber as well as for veneers. In order to save time in loading and unloading the chamber, the stacking of the green veneers can be done on trolleys outside the kiln. The loaded trucks can then be pushed into the drying chamber, which should preferably be provided with rails to facilitate the movement of the trolleys.

The Forest Research Institute, has also designed a simple type of steam-heated tunnel dryer made of masonry, in which trolleys loaded with green veneers can be moved from one end of the dryer to the other. The veneers are dried by means of hot air which is forced into the drying chamber by a powerful fan fitted outside the dryer.

In plywood factories, where steam is not available, veneers can be dried in an indirect-heated internal-fan furnace kiln provided with arrangements to facilitate the movement of trolleys loaded with veneers. This type of kiln has been especially designed by the Forest Research Institute, for this work.

The diagrammatic sketches of the steam-heated veneer drying tunnel and the indirect-heated internal-fan furnace kiln suitable for veneer drying (furnace-heated veneer drying kiln) are given in plates X and XI. The steam-heated tunnel dryer can be adapted for furnace heating as well, by suitable modifications in the design of the heater.

In order to save veneers from cracking, due to shrinkage during air or kiln seasoning, and for stacking plywood for conditioning, two types of wooden racks have recently been designed.

Full details about such kilns can be obtained from the Officer in Charge of the Seasoning Section at Dehra Dun, who will be pleased to advise on all matters relating to the air and kiln seasoning of wood in India. Detailed schemes will be supplied for any *bona fide* seasoning projects and instructions will be given as to the best method of working the kilns. If desired, kiln operators can be trained at Dehra Dun, provided there is some definite kiln seasoning plant in course of erection for which their services are required. All correspondence in this connection should be addressed to the Utilization Officer, Forest Research Institute, P. O. New Forest, Dehra Dun.

CHAPTER IV.

Wood Preservation.

The sapwood of practically all timbers is very perishable, and is liable to be destroyed within a comparatively short time by destructive agencies such as fungi (rot), termites (white ants) and borer insects. In the brackish waters of tidal rivers and in harbours, marine borers also are very vigorous in attacking piles and other marine structures, and destroying them within a very short time. The heartwood, of some timbers are naturally durable against such destructive agencies for varying periods, depending on the natural durability of the wood and the conditions under which the wood is used. Among the most durable of Indian heartwoods are teak *(Tectona grandis)*, *sal (Shorea robusta)*, *deodar (Cedrus deodara)*, *mesua* (*Mesua ferrea*), *hopea* (*Hopea parviflora*), *irul* (*Xylia xylocarpa*), Andaman *padauk* (*Pterocarpus dalbergioides*), rosewood (*Dalbergia latifolia*), black *siris (Albizzia odoratissima)* and a few other species.

The heartwood of most other Indian timbers is perishable, within a comparatively short time, if exposed to attack by fungus, termites, or borers, under unfavourable conditions. The sapwood of all timbers is of course extremely perishable. The only practical and effective remedy to prevent such perishable woods from being destroyed in service is to treat them with an efficient wood preservative. In this connection, it may be mentioned that, as sapwood is not inferior to heartwood in strength, and as it is usually far easier to treat than heartwood, it is better to use treated sapwood in preference to untreated or treated heartwood, in the case of all timbers the heartwood of which is not naturally durable or easily treatable.

Wood preservation processes.

There are several ways of applying wood preservatives to timber, the best known and most commonly used being :—

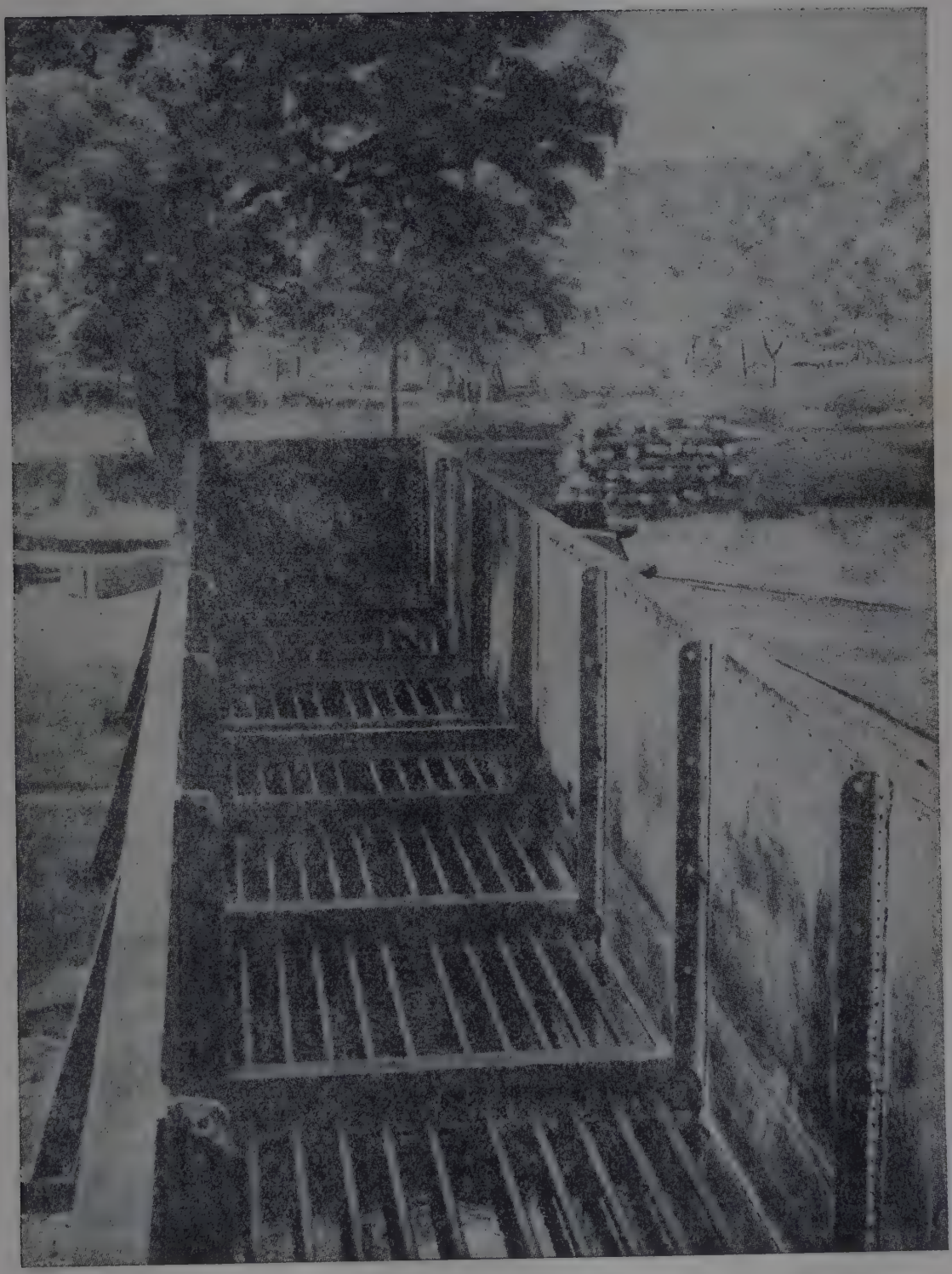
(*a*) Brush treatments or spraying (surface treatment).

(*b*) Soaking or dipping treatments.

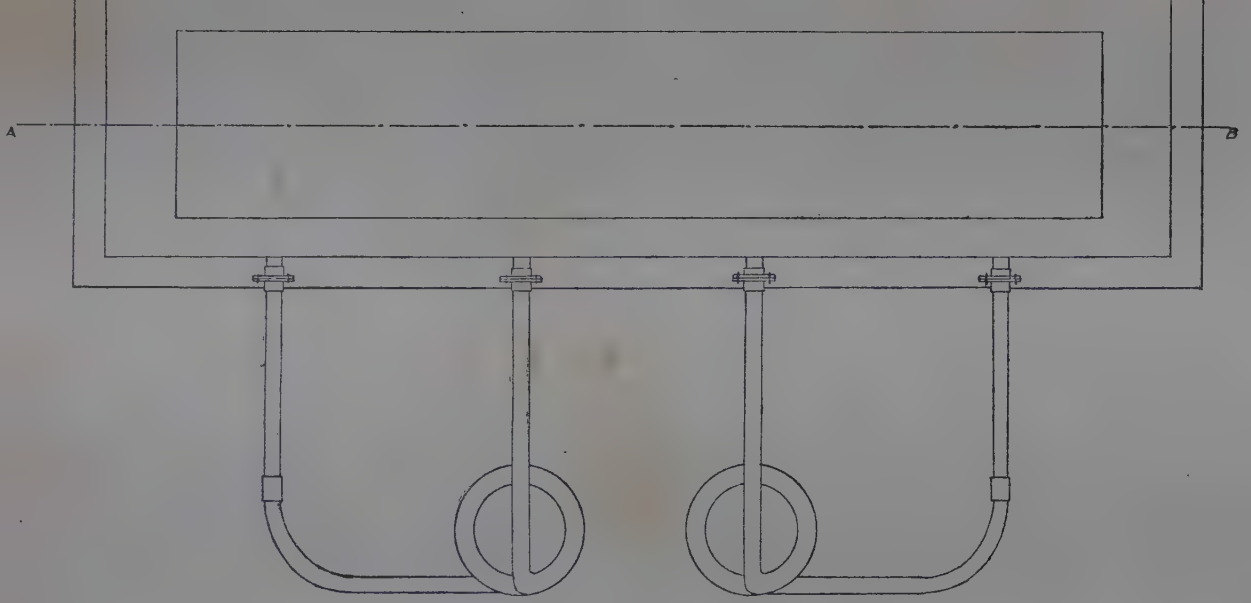
(*c*) Pressure treatments.

(*a*) *Brush treatments or spraying.*

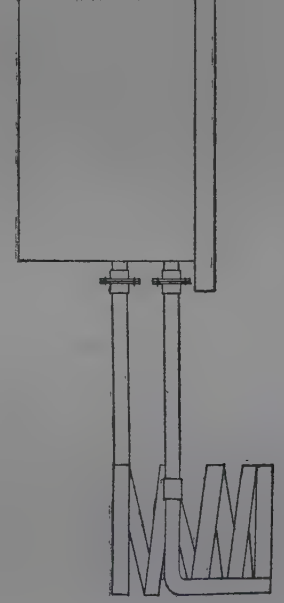
This form of treatment is the easiest to apply, but it is also the least effective. It is not a form of treatment recommended if good durability under unfavourable conditions is required. It is purely a superficial treatment and, to be of any use at all, it must be done thoroughly, and if possible repeated at intervals. It usually consists in giving the timber two coats of preservative



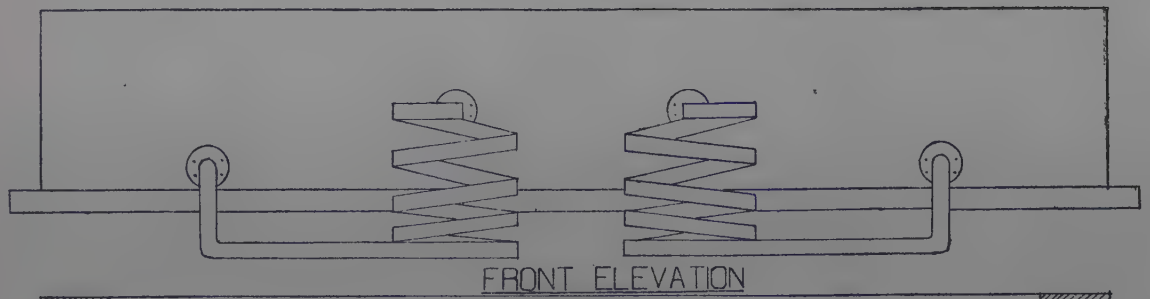
Photograph of an open tank for preservative treatment.



PLAN



SIDEVIEW



FRONT ELEVATION

SIMPLE DESIGN OF INDIRECTLY HEATED OPEN TANK

Awahal

with a brush or spray. The second coat is given after the first has dried. The wood to be treated should be thoroughly seasoned, otherwise cracks may develop later and give access to wood destroying agencies to the untreated wood below the surface. Care should also be taken to see that the wood to be treated is free of fungus attack. A brush treatment does not prevent the development of fungus already present inside the wood, and if any such fungal attack is present in the wood before a brush treatment is given, it will probably continue to develop in the interior of the wood, in spite of the surface coat of preservative. If a brush is used for the treatment, the preservative should be flowed over the wood liberally, so that the liquid can run into all cracks and joints. An oil preservative such as creosote or creosant is preferable to a water solution preservative for this type of treatment. The preservative should preferably be applied hot. If the treatment is intended only to be effective for a short time, or if the oily nature and colour of a preservative like creosote, is considered objectionable, as for example in the treatment of box shooks to prevent fungal staining or borer attack, a water solution preservative can be used. Zinc chloride, copper sulphate, mercuric chloride, sodium fluoride, Z.M.A., Wolman salts, and Ascu are examples of preservatives which can be used for this purpose. The last named should be used cold. If foodstuffs are to be packed in treated boxes, discretion should be used in the choice of preservatives as some preservatives are poisonous and may affect the contents of the treated boxes. In conclusion, it should be clearly understood that a surface treatment is not recognised as a standard form of effective wood preservation. It is fairly effective in well-ventilated seasoned timber-work in interior and sheltered locations, but it should not be used for partially ventilated work, such as floors and ceiling boards, or where the timber is installed in the ground or liable to be directly attacked by fungi or termites. Under such conditions it is of practically no value at all.

(*b*) *Soaking or dipping treatments.*

These methods of treatment are the most effective form of treatment for the small timber user who is unable to afford a pressure plant or purchase pressure treated wood.

The treatment consists in obtaining a suitable tank or drum and immersing the wood in the preservative for varying periods. Some simple and cheap types of tank are described in Indian Forest Bulletin No. 111. The best form of soaking treatment is a hot and cold treatment, known as an "open tank" treatment. This is carried out as follows:—

The preservative, with the wood immersed in it, is heated by means of steam coils in the tank or an open fire under the tank. If coal tar creosote is used, the oil is heated up to about 200°F.

When this temperature is reached, it is held for a period of from 2 to 4 hours, depending on the timber being treated and the use to which it is to be put, after which the fire is raked out or the heat cut off, and the oil is allowed to cool down to atmospheric temperature, *with the wood still immersed in it.* This is the important part of the treatment, as it is during the cooling process that most of the preservative is absorbed by the wood. When the oil has cooled down, the treatment is complete, and the wood can be removed and stacked for drying. Care should be taken, if an open fire is used under the tank, to see that no oil is allowed to run down the outside of the tank and catch fire.

This form of treatment is very effective with all timbers which absorb preservatives fairly readily, and although the penetration may not be so deep as that obtained under pressure, it is usually considerably better than the superficial treatment obtained by brushing, or by merely soaking or dipping in cold preservative. With most sapwoods and some of heartwoods, very good penetration can be obtained by using this method of open tank treatment and, where pressure treatment is not obtainable, it is the best alternative.

Almost any preservative can be used for an open tank treatment. Coal tar creosote is largely used for this purpose, and other, preservatives such as sodium fluoride, zinc chloride, Z. M. A-Wolman salts, copper sulphate, and mercuric chloride, can all be used. If Ascu is used, a slight modification is necessary, as a precipitate forms if Ascu is heated. In this case, two tanks are necessary In one, hot water only is used. The wood is first heated by being immersed in the hot water, and is then lifted out and immersed in the second tank in which cold Ascu is used. The wood cools in the cold Ascu and absorbs the preservative during the cooling process.

A simple tank for full length treatment can also be constructed by cutting the tops and bottoms out of one or more drums (depending on the length of the timber to be treated) and welding the drums together to form a long cylinder closed at both ends. Again, cutting this closed cylinder longitudinally into two halves, two semi-cylindrical open tanks can be obtained. Such a plant is illustrated in Plate XIII. In Plate XIV is illustrated a simple design of an open tank (made of brick and cement) in which the preservative is indirectly heated. In this type of tank two coils made out of $2\frac{1}{2}$" iron piping are joined to flanges on the side of the tank as illustrated. A furnace can be built round the coils. By lighting a fire in this furnace the temperature of the oil in the tank can be raised to 50° C. in a short time. The oil in the coils is rapidly heated by the fire and the hot oil is forced out into the tank from the top ends of the coils, while the cold oil from the bottom layers of the tank is automatically drawn into the coils.

Photograph of Iron drum wood preservation tank in operation.

Thus a circulation of the preservative through the heated coils is maintained and the preservative in the tank is soon heated.

Needless to say, the wood should be seasoned for all forms of open tank treatment. Green or wet wood is already saturated with liquid. It cannot, therefore, absorb much more liquid, in the form of preservative, unless most of the original sap has been dried out.

(c) Pressure treatments.

Treatment of wood in a closed cylinder, under pressure, is the best and most effective form of preservative treatment known. For this form of treatment, a properly designed pressure cylinder, together with storage tanks, pumps and pressure gauges, are necessary. There are several types of pressure treatments and several types of treating plants, and the technique of treating various kinds of wood under pressure has reached a high state of efficiency. It is not the intention to describe different forms of pressure treatment here, as this would fill a book. Anyone specially interested should write to the Utilization Officer, Forest Research Institute, Dehra Dun, when their specific problem will receive immediate attention by an expert on the subject. Suffice it is to say that the Forest Research Institute has studied the preservative treatment of practically all the common commercial woods of India. It has also made a special investigation of the merits and limitations of all common wood preservatives, and is, therefore, in a position to offer help and advice on all questions connected with wood preservation in India.

Apart from the three most common methods of treating wood mentioned above, there are some other less used and more specialised methods for treating wood with preservatives They are not, however, of very wide application and are more suited for a specific purpose with a special kind of preservative or class of timber. The "Osmose" process and the "Boucherie" process are amongst the best known. The first consists in covering green (freshly felled) wood with a preservative paste after the removal of the bark. The whole is then covered with waterproof paper and left for 2 to 3 months during which period the preservative is absorbed into the sapwood. The "Boucherie" process is used for treating green wood in the form of poles or posts. The preservative is led from a height to the end of the pole or post, and by hydrostatic pressure is forced through the length of the wood, to replace the sap, which drips out at the other end. It is a very simple process, and with certain species very effective, and the penetration in small posts or poles is often complete. A simple modification of this process is illustrated in plate XV. In this case, pieces of motor car inner tubes are fixed at one end of the post to hold the preservative, and the post is propped up with this end

slightly above the other end. The preservative then flows through the post and effectively treats it, the treatment ceasing as soon as preservative of full strength emerges at the bottom end. It is a very simple and effective method of treating fence posts *in situ*. The posts must be freshly felled and, preferably, full of sap. The duration of the treatment will depend on the nature and length of the post or pole.

Charring is another simple method of giving additional "life" to wood. It needs to be done carefully, otherwise the wood cracks, and fungus and white ants obtain ingress to the uncharred inner wood through the cracks. In Australia, it has been found that oxy-acetylene charring *plus* spraying with creosote gives better results than a brush treatment with creosote and other surface treatments.

Wood preservatives.

There are numerous commercial and proprietary wood preservatives on the market. Some are best suited for one purpose, others for another. Most of them contain some toxic principle which deters the growth of fungi or repels attacks by white ants or borers, but none is so universally used in commercial treating plants as coal tar creosote.

Coal tar creosote.

The chief merits of creosote are that it is highly toxic to wood-destroying agencies and, being oily, is a waterproofing medium. Under mild conditions, it remains in the treated wood for a very long time, but under the severe conditions sometimes experienced in India it is not always so permanent. In Europe and America, coal tar creosote is a very cheap preservative, but in India it is comparatively expensive. This, coupled with the fact that creosoting pressure plants are expensive, has been the chief deterrent to its more extensive use in India. It is nevertheless a good preservative under certain conditions and one which is very useful for "open tank" treatment. In India, coal tar creosote is generally used mixed with fuel oil. A 50-50 mixture is commonly employed. This cheapens the preservative while still retaining a reasonable amount of toxicity. Fuel oil by itself should not be used, as it has practically no toxic effect on fungi though it may have some deterrent effect on borers and white ants. Both creosote and fuel oil are available in India.

Wood tar creosote.

Wood tar creosote was, some years ago, used in South India on a fairly large scale, but its use has now been abandoned as it was found that it was not so toxic nor so permanent as coal tar creosote. It is also more corrosive to metal than coal tar creosote.

Zinc chloride.

This is the cheapest of the water solution group of preservatives. It is not, however, a very permanent preservative and it is soon leached out of wood if exposed to heavy rain or damp conditions. It is, however, highly toxic to fungi (rot), and as such is useful for timbers used under cover or not in contact with the ground. It is usually used dissolved in water in a strength of from 2 to 5 per cent. Over 2000 tons of packing-case timbers, in the form of box shooks, are treated with this preservative in Inda every year, which demonstrates its popularity for this type of work.

Sodium fluoride.

A highly toxic water solution preservative, if used in strengths of from 2 to 4 per cent. It is, however, not permanent and is liable to leach out of wood under unfavourable conditions. It is not suitable for use where the soil contains a lot of lime, as it forms an insoluble but ineffective precipitate with water containing calcium salts. Water containing calcium is therefore also not suitable for preparing solutions of sodium fluoride.

Copper sulphate.

A preservative which is highly toxic to fungi, but one which is of low permanency on account of its high solubility. It also corrodes iron and cannot, therefore, be used by itself in commercial pressure plants. It is also said to be ineffective in calcareous soils and soils manured with organic or ammoniacal manures. It is one of the constituents of several well known preservatives like Celcure and Ascu.

Mercuric chloride.

Extremely toxic to wood destroying fungi, but being also extremely poisonous to human beings and animals, its use is not extensive. It also corrodes metals.

Z. M. A.

Zinc-meta-arsenite was evolved as the result of repeated attempts to fix water solution preservative salts in wood. It is practically insoluble in water but is soluble in dilute acids. It is impregnated into wood with the aid of a volatile acid, such as acetic acid, and, after the acid has volatilised out the preservative, salts are deposited in the wood, more or less permanently. The preservative is used fairly extensively in America but has not been used to any large extent in India.

Ascu.

The ingredients of this proprietary preservative are arsenic-pentoxide, copper sulphate and potassium dichromate. The first

is highly toxic to termites, fungi and borers, and the second is highly toxic to fungi. The combination therefore forms a good toxic preservative against wood destroying agencies. The function of the potassium dichromate, besides being a toxic chemical in itself, is to "fix" the other two chemicals in the wood, so as to make them unleachable. The degree of "fixation" attained with this preservative is very good, and although the preservative has only been in use for about 7 years, it has, so far, shown itself to be one of the best preservatives tested in India if properly used. It also has the additional advantage of being used cold, which eliminates the necessity for heating apparatus in a pressure plant using the preservative. Ascu pressure plants are, as a result, very much cheaper than pressure plants for a preservative like creosote which has to be heated. Against this advantage is the fact that heat sterilises fungus-affected wood, which is a matter of some importance where inherent fungus attack is present before treatment.

In addition to the above preservatives, there are numerous other proprietary preservatives on the market. One of the best known is *Solignum*, a preservative with a creosote base. It is an excellent preservative for painting on woodwork. being highly toxic and obtainable in different colours. It also has the useful property of drying quickly. It is one of the best preservatives for the small user, but is too expensive for large scale commercial treatment. A good Indian made substitute for *Solignum* is now on the market. It is known as *Creosant* and some tests done at the Forest Research Institute show it to be a good substitute for *Solignum* and an excellent preservative for brush coatings. It has been accepted by the Army Department for brush coating timber for hutting and other purposes.

Another well known proprietary preservative is *Cuprinol*. It is not, however, very permanent in India and is more useful for treating fabrics than wood.

Other preservatives tested at Dehra Dun include Atlas solution, Jodelite, Sideroleum, Brunolinum, Cresoyle, Anthrol, Concentrol, Lignolite, Mortant, Bellit, Hylinit, Anticide, Aczol, Barol, Wolman salts, Preservol, Impregnol, Tectal, Celcure, Durol, and Chlornaphthalenes.

Their respective merits and efficiency are recorded at Dehra Dun, and any one interested can obtain information about them by applying to the Utilization Officer of the Forest Research Institute, Dehra Dun.

Sapstains.

Before closing this brief account of 'Wood Preservation', a few words may be added about sap stains. Such stains are

brought about by certain fungi which cause discolouration of freshly sawn boards of several light soft woods like *Bombax malabaricum* (*semul*), *Boswellia serrata* (*salai*), *Sterculia campanulata* (*papita*), and *Trewia nudiflora* (*gutel*). These fungi only cause discolouration of the wood; they do not damage or weaken it. They live on the food material stored in the wood cells but do not feed on or destroy the cell walls. The defect does not, therefore, affect materially the strength (except toughness to some extent) and general usefulness of the wood but only detracts from its appearance. It can be prevented by dipping the freshly sawn green boards in chemical solutions. The following have been found to be effcient: 5 per cent borax, 2 per cent Lignasan, 5 per cent Dowicide, or 1 per cent Santobrite. It is hoped that these few remarks will help to clear up some of the many misunderstandings that arise over the appearance of sapstain on wood. Too often one sees perfectly sound timber being discarded because it is sapstained and therefore presumed to be decayed. Except for appearance, such timber is as good as clean wood of the same species, and can be used for all purposes where discolouration is not a serious defect and toughness is not the main consideration.

"Fireproofing" Wood.

Despite the fact that wood is combustible, it has much to recommend it for structural purposes in comparison to steel and concrete. Combustibility is not the only criterion to be considered in the behaviour of materials towards fire. Steel and iron quickly become twisted and crushed under load in a fire, and there are a number of instances in which the superiority of wood to steel in cases of fire has been proved. By proper choice of methods of construction and suitable chemical treatments, wood can be made very fire-resistant. In recent years, in view of the importance attached to air raid precautions, the subject has gained added importance.

The requirements of a good fire-retardant agent are that it should be efficient, should not evolve toxic chemicals when exposed to fire, should be permanent, and that wood so treated should be paintable. It should also not reduce the strength of wood, should not deteriorate with time, should not be hygroscopic, should not corrode iron and steel etc., and should not favour the growth of fungi. Finally, it should also be cheap.

There is no known method of making wood absolutely "fireproof", but there are numerous chemicals and paints which can be used to make it "fire-retardant", that is to say they protect the wood from catching fire and permit it only to char slowly under normal fire conditions. For all practical purposes wood treated with an efficient fire-retardant chemical is fire proof, in as much as it does not burst into flames when exposed to fire.

Fire-retardant chemicals can be applied to wood in two ways, namely, (1) by impregnation under pressure or by soaking and (2) by painting or spraying with a fire-retardant chemical, or a paint in which fire-retardant chemicals have been mixed.

Soaking in fire-retarding chemicals is cheaper than pressure treatments and usually quite sufficient for normal circumstances The chemicals which can be used for this purpose include aluminium sulphate, ammonium phosphate, ammonium carbonate, ammonium sulphate, sodium-tetra-borate (borax), boric acid, magnesium chloride, magnesium sulphate, sodium acetate and sodium silicate, but as one chemical is often more suitable for a specific purpose than another, and as some of the above chemicals have certain drawbacks to their use under certain conditions of service, those who wish to use any of the above chemicals for making wood fire-retardant would be well advised to consult the Forest Research Institute before they embark on any venture connected with fire-retarding chemicals.

As regards fire-retardant paints, these are simple to make and use, and for all ordinary conditions of service are sufficiently effective, in fact painting is usually the most practical method to adopt where normal interior fire protection is required.

For interior use, a cheap and effective fire-retardant wash can be made by mixing ordinary lime wash or Calcimine with sodium silicate (water glass) and common salt.

Another prescription for a lime wash that has been in use for several years in America is as follows:—Half a bushel of unslaked lime is slaked with boiling water, keeping the vessel covered during the process. The lime water is strained out, and a little common salt is added. Three pounds of rice flour are then cooked with water into a paste. The lime water and the paste are then mixed with half a pound of Spanish whiting and a pound of glue dissolved in hot water. The mixture is allowed to stand for a week, and when required is heated and applied with a brush to the wood.

For exterior use, where the paint is subjected to the action of rain and sun, it is difficult to evolve a really satisfactory and permanent fire-retardant paint. Several paints purporting to be effective are on the market and others can be made from well known formulae. These are usually described as "fairly effective", which means that no really efficient and permanent fire-retardant paint for exterior use has yet been discovered. Among some of the better known of these exterior paints the following are fairly extensively used, and if re-painting is done at intervals they are good fire-retardant coatings:—Cellon, Intraven, Itex, and Porcella. "Sorel cement" mixed with fillers like asbestos has also been

found to give good protection. The following formula is an example:—

Magnesium oxide	2 parts.
Magnesium chloride solution (Sp. Gr. 1·2)	2 parts.
Asbestos (fine powder)	1 part.

A fire-retardant paint recommended by A. R. P. authorities is the following:—

Sodium silicate (in form of syrup)	112 lbs.
Kaolin (China clay)	150 lbs.
Water	100 lbs.

Another cheaper formula is:—

Slaked lime.	1 seer.
Salt	½ chatak.
Water	½ seer.

It is, however, again emphasized that such paints give protection only in inside locations and that no paint has yet been evolved which has been found satisfactory in outside locations exposed to sun, rain, and adverse weather conditions.

Finally, it may be mentioned that the smaller the dimension of the treated piece the greater the protection attained. Recent research has shown that, in large sizes, wood is able to protect itself sufficiently, and the effect of fire-retardant agents in such cases is negligible compared to the resistance offered by the wood itself, after the surface has become charred. The natural resistance to fire of Indian timbers is discussed in Indian Forest Bulletin No. 118.

Chapter V.

Descriptions of Common Indian Woods.

In the following pages. brief descriptions of the main features of some of the common commercial woods of India, are given. The descriptions are as short and concise as it is possible to make them, but they contain the latest information regarding weights, seasoning qualities, uses, etc.

Some critical readers may notice that some of the descriptions do not agree with the old text books on Indian timbers. This is due to the fact that the modern practices, now adopted at Dehra Dun, have brought to light several discrepancies in the old books. An endeavour has, therefore, been made to correct these and to give the latest and most accurate data available.

With regard to the prices quoted, it must be remembered that prices change frequently, often from month to month, and that where they are given they must be looked upon only as indications of the approximate price of the wood. No guarantee can be given that these prizes will be adhered to by those who have given the quotations.

In all quotations of prices per ton, a ton has been taken as 50 cubic feet.

Abies pindrow,

(A. spectabilis and *A. webbiana).*

Trade name.—Fir.

Vernacular names.—*Rai* (used also for spruce), *badar*, *rewar*, *tos*, *partal* (also used for spruce), etc.

Weight.—About 33 lbs. per cu. ft. (air-dry).*

Description of the wood.—The wood is creamy white to light buff. No difference in colour between heartwood and sapwood. Inclined to be knotty, and clear timber in good lengths is rare. Fairly soft and very easy to saw and work. Resembles spruce wood and is often mixed with it as one timber. A good "deal" type of wood if obtained free of large knots.

Seasoning.—An easy wood to air-season. It is very prone to fungus attack if wet, and should therefore be dried quickly after conversion. It can be stacked in the open, but should preferably be protected with thatch or shades against sun and rain, to minimise heart and ray shakes. It kiln seasons without any trouble.

Strength.—It is similar to *chir* pine in strength. Not quite so strong as deodar but stronger than spruce. For details of its strength qualities reference may be made to Appendix I.

Durability.—Fir is not a durable wood, and is very prone to fungus and white-ant attack, especially if laid in or on the ground. In the Dehra Dun "graveyard" experiments, all of the pieces under test were destroyed by white ants and fungi in about 2 years. If used for railway sleepers or in exposed positions, fir should always be treated with a good preservative, but it should be noted that it is difficult to obtain good penetration with a preservative in this wood without incision.

Uses.—Fir is a very useful light "deal" wood. It is suitable for all types of packing cases, containers and fruit crates. It would do well for some types of cheap camp furniture, and other purposes where fair strength combined with lightness is a consideration. It is often used for shingles in the Himalayas, and if treated with a preservative, is an excellent wood for this purpose. It is one of the few Indian woods which might be suitable for aircraft work, once a specification for selection is worked out. This is now being done. It is used as a treated sleeper by the North Western Railway. It can be peeled on a veneer lathe but the krotty nature of the wood makes peeling difficult. It is suitable for paper pulp, but not very suitable for matches.

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* For the air-dry weights given in this book, a moisture content of 12 per cent has been taken.

Sources of supply.—Available in large quantities in the Punjab, Kashmir, Tehri-Garhwal and other areas in North India if a demand arises. At present the actual supplies are rather limited, as the demand in the past has not been large, but it is recorded that at least 30,000 tons could be made available annually if required. The demand for fir for box shooks is, however, steadily increasing. It is extracted chiefly in sleeper form, and supplies are usually available from the sleeper depots at Jhelum, Wazirabad, Lahore, Dhilwan, Doraha, Hardwar and Jagadhri, or from any timber dealer in Northern India. If any difficulty is experienced in obtaining supplies enquiries should be addressed to the Chief Conservator of Forests, Lahore, Punjab, or the Conservator of Forests, Utilization Circle, Baramulla, Kashmir.

Prices.—Fir is usually sold in the form of sleepers, but logs in good sizes can also be bought from some depots, especially Jhelum. Fir sleepers are more often than not mixed indiscriminately with spruce sleepers. The price is usually low and is in the neighbourhood of 9 to 12 annas per cu. ft. at depots. Broad gauge sleepers usually vary from between Rs. 2 to Rs. 3 according to demand.

Acacia arabica.

Trade name.—Babul.

Vernacular names.—Babul, kikar, gobli, babur, karuvel (Tam), etc.

Weight.—About 52 lbs. per c. ft. (air-dry).

Description of the wood.—The sapwood is yellowish-white and usually wide.

The heartwood when freshly cut, is a pinkish or old rose colour, but it darkens on exposure to a dull red or reddish brown. It is often mottled with darker streaks. The wood is dull and without taste or smell, hard, fairly close-textured and with straight or slightly twisted grain.

There are several varieties of *babul* The two best known are the *telia* and *kauria* varieties, the wood of the former having a better reputation than the latter.

Seasoning.—Babul is a wood which can be air-seasoned with fairly good results if care is taken. Preferably it should be converted and stacked for seasoning during, or just after, the rains. If seasoning is started in the dry season the wood should be stacked in sheds closed on all sides to slow down the drying, otherwise excessive cracking may result. One year is sufficient to air-season *babul* boards up to 2" in thickness. It can be kiln-seasoned without difficulty.

Strength.—Babul is an extremely strong, hard, and tough wood. It is nearly twice as hard as teak and has a very good shock resisting ability. For strength details see Appendix I.

Durability.—The sapwood is not durable. The heartwood is durable is most situations but not to the same degree as teak and *sal.* It is usually used untreated, but recent information indicates that it would be advisable to treat it if the wood is to be subjected to excessive wood destroying agencies. It lasted only about 3 years in the "graveyard" tests at Dehra Dun.

Working qualities.—An easy wood to convert and to saw when green, but it becomes harder and tougher when seasoned. It works well by hand, and machines and finishes to a good surface. It takes a fair polish but requires careful filling.

Uses.—Babul is a very popular and useful fuel wood and very large quantities are consumed annually for this purpose. It is also very popular for parts of carts (bodywork, spokes, naves, axles, felloes, yokes and shafts), and for agricultural implements such as ploughs, harrows and clod-crushers. It is a useful tool handle wood but not for all types of handle, and it can be recommended for tent pegs. The Railways use it in fairly large

quantities for keys, anvil and brake blocks, and it can be described as one of the best Indian utility woods where hardness and toughness are required. It has been used for pitprops, and is also a fair turnery wood.

Sources of supply.—Babul is usually available in small logs only, but in some districts larger logs are available. It is found throughout the drier regions of North, Central and South India, the best source of supply being in Sind. Enquiries should be addressed to the Conservator of Forests, Karachi, Sind, or to the Forest Utilization Officers of Bombay Province, the Central Provinces, the United Provinces, or Madras.

Prices.—Babul is usually sold in log form, an average consignment containing short logs of about 5 ft. or 6 ft. girth. Logs up to 8 ft. girth and 12 ft. length can, however, be obtained in some districts. Logs of good quality often fetch Rs. 75 or more per ton of 50 cu. ft., but smaller logs are usually disposed of at Rs. 30 to Rs. 50 per ton if the market is dull. In the United Provinces *babul* is sold in small sizes at Rs. 20 per ton, mainly for cartwheel work.

Acacia catechu.

Trade name.—Cutch.

Vernacular names.—*Khair, kacu* (Can).

Weight.—55 to 65 lbs. per per c. ft. (air-dry).

Description of the wood.—The sapwood is a creamy white and usually wide. The heartwood is a dull pink which darkens to a dull reddish brown on exposure. A very hard and very heavy wood, without any characteristic smell or taste. Straight-grained and of medium texture A common characteristic of the wood is the presence of white specks of a powdery deposit known as *kheersal* which can be seen with the naked eye. The quality of the wood seems to be variable, that in the United Provinces for example, being good for cutch boiling but not considered as of much use as timber.

Seasoning.—Cutch is a timber of medium refractoriness to air-season. It should be converted green, not only for seasoning purposes but because drier wood is much harder and more difficult to saw. End-splitting and cracking are the most common seasoning faults, especially in thick planks and scantlings, and if seasoning is not started during or just after the rainy season, the stacks should be given protection on all sides. Seasoning for about one year is advisable for sizes up to 2" in thickness. Kiln seasoning presents no difficulties.

Strength.—Cutch is an extremely strong and very hard and tough timber. It has not been subjected to the routine strength tests at Dehra Dun but it is probably similar, if not superior, to *babul* in most strength functions.

Durability.—The sapwood is not durable. The heartwood has the reputation of being very durable, and is described by Pearson as "one of the most durable, Indian woods, which is seldom, if ever, attacked by white ants and fungi". There are several records of it having lasted for centuries in temples and it has also done well in harbour works. In the "graveyard" tests at Dehra Dun, out of 5 specimens tested 4 were slightly attacked by white ants and one moderately attacked by white ants at the end of 12 years, none being destroyed.

Working Qualities.—A somewhat difficult timber to saw and machine, especially if the wood is old and dry. A heavy-gauge plate saw with closely spaced teeth and shallow gullets gives the best results, and stiff tools should be used in machining and turning. It finishes and polishes extremely well.

Uses.—The chief use of cutch wood at present is for the production of cutch and *katha*, but it is a valuable timber apart from

these two products which it yields, and, where supplies are available, it usually finds a ready market. It is much sought after for posts in house construction and is also used for rice pestles, oil and sugar cane crushers, ploughs, tent pegs, bedpost legs, and keels and knees of boats. Kinns states that it is eminently suitable for tool handles and tool bodies (mallets and planes). Owing to its reputed durability, it will probably always be a wood which will be readily absorbed in local markets.

Sources of supply.—Cutch is found scattered throughout most of the drier districts of India. The available logs are small and the timber is usually marketted in the small sizes required by the *katha* industry. The tree is very common in the United Provinces, Bengal, the Central Provinces, and parts of the Punjab, Madras, Bombay, Assam, Bihar and Orissa. Enquiries should be addressed to the nearest Conservator of Forests in the above mentioned Provinces.

Prices.—The price of cutch logs usually depends more on their suitability for *katha* manufacture than for timber. Wood with copious white kheersal deposits always demands a good price for *katha* extraction, but this characteristic does not influence the quality of the wood as timber. The price in the United Provinces during the last few years has ranged from Rs. 3 to Rs. 12 per tree (1937). In Bengal it is quoted at Rs. 25 to Rs. 28 per ton from Buxa Division and at Rs. 3 to Rs. 4 per standing tree in the Jalpaiguri forests (1937). Orissa quotes Rs. 40 to Rs. 50 per ton, the Central Provinces Rs. 50 to Rs. 60 per ton and Bombay up to Rs. 60 per ton, according to quality (1937).

Adina cordifolia.

Trade name.—Haldu.

Vernacular names.—Haldu, heddi, (S. India), *karam,* etc.

Weight.—40 lbs. per c. ft. (air-dry).

Description of the wood.—Haldu is a yellow or straw-coloured wood with a fine even texture which places it high in the ranks of carving and turnery woods, though it is not up to the same standard as boxwood in this respect. The sapwood, which is yellowish-white, merges gradually into the heartwood. The wood is lustrous with a smooth feel but without taste or smell. Usually fairly straight-grained but sometimes with broadly interlocked bands of fibres.

Seasoning.—Haldu presents no great difficulties as regards seasoning, and if converted material is protected from the direct rays of the sun, it usually seasons with little degrade even in the open. Small surface-cracks and end-splitting are the most usual defects, and unseasoned wood is definitely liable to insect attack. For this reason logs should be converted as early as possible after felling, and if they have to be stored it is a most necessary precaution to remove the bark.

Under favourable air-seasoning conditions the wood dries very quickly, and 1-inch boards have been dried from 50 per cent to 6 per cent moisture content in two months in Dehra Dun.

Kiln-seasoning presents no difficulties, *haldu* being a very amenable wood to kiln-drying. Seasoned *haldu* is, however, susceptible to climatic changes, even when made up into furniture and polished, and Pearson states that a clearance of 2·5 per cent should be allowed for this not uncommon feature of many Indian woods.

Strength.—Haldu is a fairly hard and strong wood. It is about 10 per cent harder than teak but slightly weaker in transverse strain, elasticity, and compression. For details of strength see Appendix I.

Durability.—Seasoned *haldu* is a wood of moderate durability, and judging by the fact that it is popular with Railways for wagon floor boards and is commonly used for doors, window frames and boarding, it is not considered to be a very perishable wood, but an antiseptic treatment would be advisable if great durability is required. It is a very easy wood to treat, even in the heartwood. In the "graveyard" tests at Dehra Dun it lasted about $3\frac{1}{2}$ years in an untreated condition.

Working qualities.—*Haldu* is a very easy wood to saw and machine and one of the nicest Indian woods to work by hand and to turn. It also finishes very easily and takes stain and polish remarkably well. Kinns puts the cost of working at about 65 per cent that of teak. It cannot be dovetailed in a dovetailing machine because it breaks away.

Uses.—*Haldu* has already established itself, not only in India but also in Europe, as an excellent light-coloured wood for turning, carvings, some types of bobbins, furniture, panelling and household fitments. It is popular in India for such articles as toys, combs, brushbacks, fret-saw work, rulers, and grain-measures. It is the best wood used by the Bareilly bobbin factory for bobbins, stubbing tubes, skewers and rover tubes, although it is not quite up to the quality of European beech for this purpose, being slightly more brittle. It is a most suitable wood for such purpose as bathroom, bakery, and kitchen fitments, and has been used with very satisfactory results as a decorative panel wood in Europe and Burma. It has also been used in India as a pencil wood but it is really too hard for this purpose and needs artificial softening. One railway workshop in India reported that they considered *haldu* to be the most useful Indian timber next to teak, and for such purposes as floorings, roof boards, panelling, and fitments in railway carriage work it is a most useful timber. Finally, it is a good peeling wood and makes up into an excellent plywood for general utility work.

Sources of Supply.—*Haldu* is found scattered throughout the deciduous forests of India. Fairly large supplies are available from the Gonda and Bahraich Divisions in the United Provinces, and from Nepal. Smaller supplies are forthcoming from other Divisions in the United Provinces and from Bengal, Assam, Bihar, Orissa, the Central Provinces, Bombay and Madras. Very large logs are often available, though such logs are often fluted and hollow, but this does not detract from the value of the wood itself. Enquiries for this timber should be addressed to the nearest Conservator of Forests, or the Forest Utilization Officer of the Province concerned.

Prices.—As with any timber found scattered throughout India, the prices of *haldu* vary considerably. Recent quotations (1937) are as follows;—

Assam.—Rs. 37-8 per ton in logs of 20 ft. length and upto 4½ ft. girth.

Bengal.—Rs. 25 to Rs. 60 per ton in logs from Kurseong and Chittagong Divisions.

Bihar.—Rs. 22 to Rs. 32 per ton in logs from Palamau and Singhbhum Districts.

Bombay.—Rs. 15 to Rs. 95 per ton from Dandeli, Hubli, Dangs, and other Districts.

Central Provinces.—Rs. 50 to Rs. 75 per ton in logs of 3 to 5 ft. girth,

Orissa.—Rs. 31 to Rs. 44 per ton for logs upto 7 and 8 ft. girth.

Madras,—Rs. 37 to Rs. 75 per ton according to size and quality.

United Provinces.—Rs. 7 to Rs. 35 per ton from Gonda Division in logs of 15 ft. and up in length and 8 ft. to 9 ft. midgirth.

Albizzia species.

There are several common commercial *Albizzia* woods. The best known is perhaps *Albizzia lebbek*, the others being *A odoratissima*, *A. procera*, and *A stipulata*.

Trade names.—*Kokko* (*Albizzia lebbek*). Black *siris* (*Albizzia odoratissima*). White *siris* (*Albizzia procera*).

Vernacular names.—*Siris, bage* (Coorg) (*A. lebbeck*); *kala siris, khanker siris* (*A. odoratissima*): *safed siris, velvagai* (Tam) (*A. procera*), and *boumeza* (*A. stipulata*).

Weights.—*Kokko.*—about 40 to 42 lbs per c. ft. (air-dry). Black *siris.*—about 55 lbs per c. ft. (air-dry). White *siris.*—about 38 lbs. per c. ft. (air-dry).

Description of the woods.—All three of the *siris* spices have very similar timber. The sapwood is white and often fairly wide. The heartwood is a rich walnut brown, often handsomely streaked with lighter and darker markings, and with a pleasing golden lustre which shows up well under polish. The wood has very large pores which need to be well filled to obtain a good polish. The texture otherwise is very even, but the grain may be straight or interlocked in broad bands. If stock is selected, these woods can be among the most handsome of Indian timbers.

Seasoning.—The *Albizzias* are moderately refractory woods to season. They have a tendency to end-splitting and some surface-cracking, but if properly stacked and well protected against too rapid drying, they usually behave well. One-inch stock should be seasoned for 6 to 9 months according to conditions, while thicker stock will take considerably longer. It is always advisable to coat the ends of logs and large dimension stock. Kiln-seasoning presents no difficulties, and it is preferable to kiln-dry these woods if kilns are available. Once seasoned they are very steady.

Strength.—*Kokko* is a strong wood, being about the same weight and hardness as teak. For details of its strength see Appendix I. Black *siris* is a havier, harder and stronger wood than teak, while white siris is lighter and slightly weaker, except in shock resistance and shear in which it is 40 per cent and 30 per cent respectively stronger than teak.

Durability.—These woods are only moderately durable in outside locations but are durable in inside locations. The heartwood is, moreover, very difficult to treat with preservatives, but the sapwood is easily treated. In the "graveyard" tests at Dehra Dun, untreated. *A stipulata* was destroyed within 44 months. *A lebbek*

and *A procera* averaged about 75 and 80 months respectively. With *Albizzia odoratissima* only 2 specimens were destroyed in 7 years, while 2 were slightly and 2 moderately attacked at the end of 13 years.

Working qualities.—Due to interlocked fibres the *siris* timbers are not always too easy to saw and machine. They can, however, be finished to a good surface by hand, but they all require careful and repeated filling on account of the large pores. They take an excellent polish. *Kokko* has the misfortune to cause a nasal irritation, temporay but unpleasant, when being sawn, and on this account it is not too popular amongst carpenters. The other two species are free from this defect. The *Albizzias*, as a whole, are not good subjects for rotary veneer cutting, but as sawn or sliced veneers they would be excellent. They are handsome woods, and if properly worked and finished they well repay the labour expended upon them.

Uses.—These woods are worthy of special notice. They are excellent for high class furniture, interior decoration, and panelling. All three of the *siris* woods can be extremely handsome if a proper selection is made, and the golden sheen, which they retain permanently, enhances their value. They can be recommended for all furniture such as desks, tables, chairs, screens, almirahs, and chests-of-drawers, and in Great Britain *kokko* is already well-known for parquet and strip flooring, panelling, and railway carriage work. In India they are also extremely useful constructional woods but they are not as popular as they might be, *kokko* on account of the nasal irritation it causes, and white *siris* on account of a religious prejudice in some districts (Bengal and the United Provinces) against felling it.

Sources of supply.—The largest supplies of *kokko* come from the Andamans. It is also found in more limited quantities in Bengal, Assam, Bombay, Madras, the Central Provinces, the Punjab and the United Provinces. Squares of 12″ to 30″ siding, and up to 30 ft. length, are available from the Andamans.

Black *siris* is available in the Central Provinces, Assam, Bombay the United Provinces, Orissa, and Madras, being fairly common in some districts and rare in others.

White *siris* is available from the United Provinces, Assam, Bengal, and Bombay. *Boumeza* is available from the Andamans, the Punjab and the United Provinces in limited quantities only.

Enquiries should be addressed to the nearest Conservator of Forests, or to the Chief Forest Officer, Port Blair, Andaman Islands.

Prices.—The prices of Andaman *kokko* squares usually keep fairly steady and may be quoted at about Rs. 80 to Rs. 100 f.o.b. Port Blair, Andaman Islands (1937). The Indian prices are usually slightly lower than the Andamans, and the prices for black and white *siris* are usually lower than those of *kokko*.

Albizzia amara.

The Chief Conservator of Forests, Bombay, has asked that this species may be mentioned. Its Bombay name is *lallei*. The wood is probably slightly superior to *kokko* from a cabinet making point of view, as it often has a purplish cast and is sometimes beautifully mottled with dark and light shades (Pearson). Its weight is 54 lbs. per c. ft. (air-dry), and it is said to be very durable. It works to a beautifully smooth finish and is worth further attention. It is not a wood which has been handled much at Dehra Dun, but supplies could be obtained through the Chief Conservator of Forests, Bombay, or from the Central Provinces, Madras, Mysore, or Travancore. It appears to have the qualities of a first class cabinet wood.

Altingia excelsa.

Trade name.—Jutili.

Vernacular name.—Jutili.

Weight.—45 lbs. per c. ft. (air-dry).

Description of the wood.—The heartwood and sapwood are not distinct. The wood is a reddish-brown colour, even textured, hard, and sometimes with interlocked fibres.

Seasoning.—A very difficult wood to air-season without degrade from surface cracking. Green conversion and very slow drying are recommended (Kapur). One inch boards and 4" x 2" scantlings took about two years for thorough seasoning in Dehra Dun. *Jutili* is very difficult to kiln dry also. It is liable to twisting, warping, cracking and the formation of moisture pockets during kiln seasoning. (Rehman).

Strength.—No scientific tests have been carried out on this wood. It is known to be hard and strong and probably approaches teak in other strength qualities.

Durability.—Jutili is fairly durable in the open. It lasted 6 years as an untreated sleeper in Assam, and about 80 months in the "graveyard" tests on untreated woods at Dehra Dun. It would be advisable to treat it for use in or on the ground or in exposed positions. It has done very well as a treated sleeper, but the heart-wood is difficult to treat with preservatives.

Working qualities.—A difficult timber to work and saw when dry. It is a good deal easier when green. Not recommended for cabinet making or turnery.

Uses.—Jutili can be classed as a sound constructional or sleeper wood, It is used in Assam and Burma as such, and if treated is very suitable for such work.

Sources of supply.—This species is found only in Assam. It is a large tree but the timber is not very well known except locally where it occurs. Enquiries should be addressed to the Conservator of Forests, Shillong Assam.

Prices.—The price is not high near the sources of supply, but if exported to a distance, the price might become prohibitive Rs. 40 per ton is the price quoted by Assam for logs up to 24 ft. in length and 5 ft. in girth. Squares of 15 inch siding are quoted at Rs. 1-7 per c. ft. (1937).

Anisoptera glabra.

Trade name.—Kaunghmu.

Vernacular name.—Kaunghmu (Burma), *boilam* (Bengal).

Weight.—About 36 lbs. per c. ft. (air-dry).

Description of the wood.—The wood is a pale reddish brown, light but strong, and finishing to a clean bright surface. It is closely related to, and not unlike light coloured gurjan.

Seasoning.—No authentic record is available as to the seasoning properties of *kaunghmu*, but from what is known of the wood it should not be difficult to season.

Strength.—Standard strength tests have been done on this wood, and the results can be seen in Appendix I. It is slightly lighter and weaker than teak,

Durability.—Kaunghmu is not a durable wood, and should be treated with a good preservative if it is likely to be subjected to fungus or insect attack. All 6 of the untreated specimens tested in the "graveyard" at Dehra Dun were destroyed by termites within a period of 3 years.

Working qualities.—Reported to be very easy to work and to polish (Allsop). It peels well on a rotary lathe and makes up into good quality plywood for ordinary commercial work.

Uses.—A good commercial light wood for crates, boxes, and containers of all kinds. Very suitable for cheap furniture, and recommended by the Burma authorities for plywood and veneer work.

Sources of supply.—Available only from Burma, and Bengal. Trees of 10 to 15 feet girth are not uncommon and a minimum girth of 6 ft. is guaranteed. Large supplies (up to 1,000 tons per annum) could be produced from Burma if the demand arose.

Prices.—Burma quotes Rs. 50 per ton as an average price for logs f. o. r. Rangoon (1937).

Anogeissus species.

There are two woods of the *Anogeissus* family which are of commercial importance in India.

Trade names.—*Yon (Anogeissus acuminata);* axle-wood (*Anogeissus latifolia*).

Vernacular names.—*Yon* (Burma), *chakwa* (Bengal), *dindiga* (Coorg), *vekkali* (Tam), *dhaura, bakli, dhawa, dhau*, etc.

Weights.—*Yon.*—About 50 to 55 lbs. per c. ft. (air-dry). Axlewood.—about 58 to 62 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwoods greenish or yellowish grey to light brownish grey. Heartwoods chocolate or purplish brown, usually small. Both woods are heavy, strong, tough and elastic, with a fairly fine texture and straight or slightly interlocked grain.

Seasoning.—Both timbers are difficult to air-season and require great care if warping, splitting, and surface-cracking are to be avoided. The best procedure is to convert logs during or just after the rainy season, and to stack the converted material without delay under cover with protection on all four sides for slow drying. Great care should be taken to see that the converted material is well and evenly stacked, as both timbers are very prone to twisting and warping. It is preferable, on this account, to season them in plank form, even though the final stock is to be in square scantlings for tool handles. The seasoned planks can then be re-cut into the sizes required, and these can be re-conditioned for a further short period. This procedure would probably minimise loss on account of warping and twisting (Kapur). Kiln seasoning does not present any great difficulties.

Strengths :—It is due to the great strength of these woods, especially in shock resistance, transverse strain and hardness, that they have achieved a well-earned reputation as substitutes for ash and hickory for shafts, helves and tool handles.

Yon is slightly superior to axle-wood, but both are equal to ash for tool handle work, and good *yon* can compete with average hickory in most strength functions. As hickory is recognised throughout the world as the best known commercial tool handle wood, this is no mean achievement. Strength figures for both *yon* and axle-wood, compared with teak, will be found in Appendix I.

Durability.—Neither timber can be described as very durable but *yon* has a greater natural durability than axle-wood. In the "graveyard" tests at Dehra Dun two out of the six specimens tested were still standing after 92 months. Axlewood lasted only 31 months. As they both have large sapwoods it would be advis-

able to treat them with a good preservative if they are to be used in exposed positions. It is not difficult to treat the sapwood but the heartwood is more refractory.

Working qualities.—Both woods are hard and tough and consequently not too easy to saw, but with care they can be machined, turned, and finished to a smooth shiny surface.

Uses.—Both *yon* and axle-wood have established themselves as first-class tool handle woods, if properly seasoned, and this will probably be the main future use of these woods. Formerly they were not over popular with local craftsmen, probably on account of the seasoning difficulties, but they were always recognised as strong woods and were in use as poles, cart shafts and axles, plough handles, etc. Now that more is known about their seasoning there should be no difficulty in marketting these woods for tool handle work. The Indian railways have already recognised their value and have included them in their list of recognised tool handle woods. A well established trade in Burma *yon* handles is increasing annually and is difinitely ousting foreign imports of ash and hickory. It has been estimated that at leat 2,000,000 tool handles are required annually in India, so there is plenty of scope for expansion in the Indian trade.

Sources of supply.—Burma is at present the chief source of supply of *yon* wood, and good supplies are available, either in log form, or in more limited quantities as half-wroughts for tool handles. It is also available in the Orissa States' forests, where supplies of 100-150 tons per annum have been estimated.

Enquiries should be addressed to the Conservator of Forests, Utilization Circle, Ahlone, Rangoon, or to the Forest Adviser, Eastern Estates, Sambalpur.

Axle-wood is found in the deciduous forests of India, but not in Burma or the Andamans. Very large logs are not available, the average running to about 5 ft. in girth. It is a common tree in some districts and scarce in others, and enquiries should be addressed to the nearest Conservator of Forests as regards the best sources of supply in the United Provinces, the Central Provinces, Bombay, Madras, Bihar, and Orissa. It is not available in Bengal and Assam.

Prices —Burma quotes about Rs. 50 per ton and upwards for *yon* logs of an average girth of 5 ft. f. o. b. Rangoon. The price in Calcutta would probably be about Rs. 75 per ton. Axle-wood varies in price in different localities but as a rough guide it can be quoted at about Rs. 50 to Rs. 75 per ton at forest depots (1937).

Anogeissus pendula.

Anogeissus pendula (*kardahi*) is a small tree of Central India. It is fairly common in the Forest Divisions of Jhansi (U.P.) and Saugor (C. P.). It is an exceptionally strong wood, and apart from the small sizes available, suitable for helves, etc., where great strength is required. Its weight is about 58 lbs. per c. ft. (air-dry). Its strength qualities can be seen in Appendix I.

Anthocephalus cadamba.

Trade name.—Kadam.

Vernacular name.—Kadam, roghu.

Weight.—34 lbs. per c. ft. (air-dry).

Description of the wood.—A straight-grained, even-textured white or creamy coloured wood, obtainable in fairly large sizes. Fairly common in East India, more especially in Assam and Bengal. A non-ornamental timher of good grade.

Seasoning.—An easy wood to season. It is not very prone to cracking and warping but is liable to stain if not dried quickly. Logs should be converted green and the timber stacked at once with crossers, preferably under cover, with a good free circulation of air through the stack.

Strength.—Kadam is only a moderately strong wood and is rather soft. For practical purposes it can be taken as having between 65 and 80 per cent the strength of teak.

Durability.—Kadam is not a durable wood and is liable to stain. It is, however, a timber which can be treated easily and completely with preservatives and, if used in exposed positions for any length of time, it should always be treated. Untreated specimens of this timber tested in the "graveyard" at Dehra Dun were all destroyed by white ants within 23 months.

Working qualities.—A very easy timber to saw and work to a fine surface. Can be peeled without trouble on a rotary veneer lathe.

Uses.—It is used fairly extensively in Assam and Bengal for ceiling boards and light construction work. It is a typical cheap boarding and packing case wood, and if treated would be an excellent general utility timber of the lighter type. It is an established match wood in Burma where it is used for splints.

Sources of supply.—Assam reports that *kadam* can be supplied up to about 350 tons annually in logs of about 24 ft. length and 4 ft. girth. Smaller quantities are available in Bengal from Kurseong, Chittagong and Buxa Divisions. Available also in Burma, where it is known as *mau-lettan-she*, and from the Andamans. Enquiries regarding this timber should be made to the Forest Utilization Officers of Bengal (Calcutta) and Assam.

Prices.—Assam quotes Rs. 28 per ton for logs (1937) and Rs. 1-2 per c. ft. for sawn material $18' \times 12'' \times 12''$. Bengal quotes Rs. 18 to Rs. 30 per ton in logs according to quality and size.

Artocarpus species.

Trade name.—Chaplash (Artocarpus chaplasha). aini (Artocarpus hirsuta), jack (*Artocarpus integrifolia)* and *lakooch (Artocarpus lakoocha)*.

Vernacular names.—Sam, hebalsu, kanthal, dhau, bharas (Beng.) *pilavu* (Mal.), *halasu* (Coorg).

Weight.—Chaplash 34 lbs. per c. ft., *aini* 37 lbs. per c. ft., jack 36 lbs. per. c. ft., and *lakooch* about 40 lbs per c. ft (air-dry).

Description of the woods.—Chaplash varies in colour from yellowish to brown. It is a moderately hard ornamental timber with an even but rather coarse texture. *Aini* can best be described as having a close resemblance to teak. It is a very superior utility wood of excellent quality. Jack, when freshly cut, is usually a bright yellow but dulls down to a light brown on exposure. The tree is preserved more for its fruit than its timber, but jack wood is, nevertheless, an excellent wood if supplies are forthcoming. *Lakooch* is very similar to jack in appearence, and it is possible to obtain some very handsome wood from this species. To sum up, the woods of *Artocarpus* species are very useful brownish woods of good quality. They are all well known locally where they occur and are used for a wide range of purposes. Ornamental boards can be obtained from all of them with proper selection.

Seasoning.—All the *Artocarpus* species season easily without trouble or degrade. *Aini* is a model timber in this connection. For air-seasoning, the converted material should be stacked in open piles with a good circulation of air through the stack. Kiln-seasoning in the same way offers no difficulties with any of these species.

Strength—Chaplash is a reasonably strong wood of about 75 to 80 per cent the strength of teak. *Aini*, weight for weight, has practically the same strength as teak. It is 10 per cent lighter and about 10 per cent below teak in all strength qualities. It approaches teak very closely in retention of shape. Jack is probably similar to *Chaplash* in the matter of strength. Strength figures will be found in Appendix I. *Lakooch* is a slightly heavier wood and is possibly stronger than *chaplash* but no strength figures are available. For the details of strength figures for *chaplash* and *aini* reference should be made to Appendix I.

Durability.—Chaplash, aini, jack and *lakooch* all have the reputation of being durable. They are certainly above the average in this respect and probably have a durability approaching that of teak. They are not timbers which treat very easily, in fact

chaplash is recorded as being very difficult to treat at all. *Aini* and jack could be used for most purposes untreated, and according to C. C. Wilson of Madras there are boats of *aini* in daily use on the West Coast which are 200 years old. In the "graveyard" tests at Dehra Dun jack was untouched after 3 year in the ground, while *aini* and *lakooch* were slightly touched by fungus, but untouched by white ants at the end of the same period. *Chaplash*, and especially *lakooch* are very resistant to marine borer attack.

Working qualities.—Chaplash saws and works well, but it has bands of interlocked fibres and therefore requires careful working to bring it to smooth finish. It also has rather large pores and needs to be well "filled" before polishing. It is a smooth-textured wood and suitable for turnery and carving. *Aini* is an excellent wood from the working point of view and presents no difficulties. It is easier to saw, turn, finish and polish than teak. Jack is also an easy wood to work and presents no difficulties. *Lakooch* has a reputation of being hard to saw, but at Dehra Dun it has always been found to be an easy wood to saw, plane and finish. Burma also reports that it is easy to work and polish.

Uses.—Chaplash is a medium weight wood suitable for light and heavy constructional work, furniture, ship-building, packing boxes and most general purposes. Often very ornamental and therefore worth selection for furniture and panelling. Finally, it is a good peeling wood and makes up into an excellent plywood for general utility work.

Aini is well known in South India as being equal to, if not better than teak, for constructional work, carriage building, furniture and turnery. Supplies are usually snapped up at once and do not cover the demand. Would probably make an excellent parquet floor wood and sell for good prices in block form. Jack is limited in the matter of supplies, but where available is an excellent cheap wood for general carpentry, plain furniture or construction work. It is used also for brush backs, inlay and turnery work. *Lakooch* is popular for house construction work and medium-weight furniture, boat-building and other purposes. It is a valuable wood and much prized in the Andaman Islands for pier and jetty piles, posts and rafters, as also is chaplash. Chaplash is an excellent timber for planking light boats.

Sources of supply.—Chaplash is obtainable in Assam and Bengal in fair quantities, and from the Andamans if there was a a demand. Assam can produce about 350 tons per annum and Bengal possibly more in logs up to 6 ft. girth *Aini* is obtainable only in South India and Bombay, and the demand exceeds the supply. Enquiries should be addressed to the Forest Utilization Officer, Madras, or the Chief Conservator of Forests, Bombay.

Jack is found throughout the warmer regions of India as a scattered and planted tree. The best sources of supply would probably be in Madras and Bombay. Elsewhere it will not be found in commercial quantities. *Lakooch* is found in Assam, Bengal, and on the West Coast in Madras and Bombay, but is not common and is usually seen as a cultivated tree rather than as a commercial forest tree.

Prices.—Assam quotes Rs. 45 per ton for chaplash logs of 18 ft. length and 6 ft. girth and Rs. 1-8 per c. ft. for sawn material $24' \times 18'' \times 18''$. Bengal quotes Rs. 25/- to Rs. 50 per ton in log form for this species (1937).

Aini is quoted at Rs. 28 to Rs. 50/- per ton in Madras and Rs. 40 to Rs. 50/- pet ton in Bombay in log form (1937).

Jack is usually in good demand locally and the prices would probably be much the same as for chaplash. The same would probably hold good for lakooch.

Betula alnoides.

Trade name.—Indian birch, sometimes called Naga birch.

Vernacular names.—*Hlosunli, saur, sons* (Beng.).

Weight.—41 lbs. per c. ft. (air-dry) for Bengal specimens but the same species from the United Provinces weighed only 32 lbs. per c. ft.

Description of the wood.—A good quality straight-grained, even textured white or greyish wood, without any characteristic odour. A really first class timber for interiors of furniture and cabinet work. It is one of the few Indian woods which is recorded as being up to European standard for plywood work, and in the opinion of the Officer in Charge of the Woodworking Section at Dehra Dun it is one of the best and most satisfactory woods he has ever had to deal with.

It is closely allied to *Betula cylindrostachys*, another Himalayan member of the birch family.

Seasoning.—No official opinion as to the seasoning qualities of Indian birch is on record, but it is being used by a commercial firm in Calcutta and they have reported no difficulty with it other than a tendency to open slightly at joints after manufacture into cabinets. As a veneer it dried easily and without degrade at Dehra Dun.

Strength.—No official strength figures are available for this wood, but it has the reputation of being esteemed for its strength in Nepal (Pearson). In some strength tests on plywood of Indian birch done at Dehra Dun, it surpassed the standard datum figures of imported plywood, and it did exceptionally well when it was tested in the form of plywood tea-boxes. It is, therefore, obviously a wood of respectable strength.

Durability.—The wood appears to be liable to stain if left lying too long after felling, but it has a reputation in Nepal for durability (Pearson). It is probably a moderately durable wood under normal conditions, but not so if exposed to severe attacks of fungi or termites. Nothing is known concerning its amenability or otherwise to preservative treatment.

Working qualities.—A very easy wood to saw, work, peel, turn and finish. Many small articles have been made with it at Dehra Dun and it has always behaved in an exemplary fashion under all conditions of working.

Uses.—A really good quality wood for plywood, interiors of cabinet work, turnery and other uses. It seems to be a very steady

wood and one which gives very little trouble. Numerous handles for such tools as screw-drivers, planes, and saws were made from this wood at Dehra Dun and it proved to be excellent for this purpose. It is used for gramophone and wireless cabinet work in Calcutta and has been reported on very favourably. Unfortunately only small sizes are at present available in the Calcutta market and this may restrict its uses somewhat.

Sources of supply.—Available from the Northern Circle of Bengal, where 50,000 c. ft. are said to be available annually. Here it is however only being extracted in small logs up to about 3 ft. in length and weighing less than $1\frac{1}{2}$ maunds, as all extraction at present is by ropeway which limits the sizes extracted. It occurs in other hill forests along the Himalayas, but is not extracted elsewhere in any quantity.

Prices.—Bengal quotes Rs 50 to Rs. 80 pet ton in sawn sizes, presumably at the ropeway depot (1937). Freight to Calcutta would add an another Re. 1 per c. ft. Enquiries for this wood should be addressed to the Forest Utilization Officer, Alipore, Calcutta.

Bischofia javanica.

Trade name,—Bishop wood.

Vernacular names.—Uriam (Ass.), *paniala*, *neeli* (Coorg), *cholavenga* (Mal), *kainjal* (Nep.).

Weight.—35 lbs. to 48 lbs. per c. ft. (air-dry). The weight of this wood seems to vary considerably.

Description of the wood.—A dull red or reddish brown wood, sometimes with a dark purplish tinge. It is usually straight grained with a coarse but even texture. Handsome panels with a wavy grain can sometimes be picked out of a stock of this timber but it is usually dull and more a constructional than an ornamental wood.

Seasoning.—Bishop wood has a tendency to warp and crack. When air-seasoning this timber care should be taken to protect it from too rapid drying. Kiln-seasoning on the other hand presents no difficulty, and timber kiln-seasoned at Dehra Dun came out of the kiln in an excellent condition.

Strength.—Bishop wood is about the same weight and of about the same hardness as teak. In other respects it has only about 75 to 80 per cent the strength of teak, except in the case of shear strength in which it is equal to teak. For details of the strength figures Appendix I should be consulted.

Durability.—A moderately durable wood but not one which will survive for many years in an untreated state under severe conditions. In the "graveyard" tests at Dehra Dun it lasted for about $4\frac{1}{2}$ years. The sapwood treats readily but the heartwood is very refractory to preservative treatment. Sleepers of this timber treated with creosote and laid in Assam lasted 15 years. The sapwood absorbed 4 to 5 lbs. of preservative per c. ft. The heartwood absorption was only skin deep.

Working qualities.—Bishop wood is not a difficult timber to saw and work to a fine finish. It also polishes well.

Uses.—The wood is well known in Assam where it is used for constructional purposes, such as bridges, house posts and rafters, etc. It has also been used as sleeper wood, both treated and untreated, but without preservative treatment it is not likely to last more than 4 or 5 years. If used treated, it is an excellent sleeper and constructional wood. Selected planks would be useful for furniture making, but taken as a whole it is more a constructional than an ornamental timber.

Sources of supply.—The main supplies are to found in Bengal and Assam. Bengal has good quantities in Buxa Division and

smaller quantities in other Divisions and wants to find more extended markets for it. Assam can produce 400-500 tons per annum in logs of up to 25 ft. length and 5 ft. girth. Madras can also supply limited quantities if there is a demand.

Prices.—Assam quotes about Rs. 38 per ton in log form and Rs. 1-4 per c. ft. for squares of 15 inches siding and 24 ft. length (1937).

Bengal prices bishop wood at Rs. 20 to Rs. 30 per ton (1937), while Madras puts it at Rs. 27 to Rs. 34 per ton in the log (1937).

Bombax species.

(*Bombax malabaricum* and *Bombax insigne*).

Trade name.—*Semul.*—This is now the official trade name for both species. The tree is known as the Indian cotton tree.

Vernacular names.—*Semul, buruga* (Coorg), *poola* (Mal.), *letpan* (Burma), (*Bombax malabaricum*); *didu* (Burma and Andamans) (*Bombax insigne*).

Weight.—*Bombax malabaricum* 23 lbs, per c. ft.; *Bombax insigne* is slightly heavier and weighs about 30 lbs. per cu. ft. at 12 per cent moisture content.

Description of the wood.—*Semul* wood is too well known in India to need much description. It is a very soft creamy white or pale pink timber, very light in weight and with large open pores. It is an extremely perishable wood, and is usually attacked by fungi and insects within a very short time of felling and conversion. Nevertheless it is one of India's most useful woods, being fairly plentiful and cheap, and readily available in almost all parts of the country although the demand is steadily increasing. It is used for a variety of purposes, the chief of which are plywood, packing case manufacture and matches. In short, *semul* is to India what the common deal woods are to Europe and America.

Seasoning.—Being very prone, especially in warm and moist atmospheres, to rapid fungus and insect attack, *semul* must be dried immediately after conversion if loss is to be avoided. Quick drying can be achieved by exposing freshly converted timber directly to the drying action of the sun and wind or by kiln seasoning. If air-seasoning is to be done, the best method is to stack the freshly sawn stock in a vertical position against a building or railing with the planks facing the sun. The boards should be turned from time to time so that both surfaces are exposed. This results in rapid drying of the surface of the boards and is usually sufficient to prevent fungal staining, but the stock is liable to some warping and splitting as the result of such drastic conditions. Another, and possibly better, method is to place the freshly converted boards in clean water for a month or so, and then to dry them in open stacks with a good air-circulation. This usually results in good clean boards being obtained.

Kiln-seasoning is, however, the surest and best method of drying *semul*. Under kiln-seasoning conditions it dries rapidly and without degrade, and anyone using *semul* wood in any quantity would be well advised to instal a cheap seasoning kiln, which would result in clean dry stock being available throughout the year,

Strength.—*Semul* is not a wood which is used for its strength properties. It is a soft weak wood and cannot be considered where strength qualities are required. *Bombax insigne* is slightly harder and heavier than *Bombax malabaricum* and both have sufficient strength to make them suitable for light cheap painted furniture, but not for constructional purposes.

Durability.—Both *semul* and *didu* are highly perishable woods. They are attacked within a few days of conversion by insects and fungi, and are especially prone to blue staining. On the other hand, they can be readily treated with preservatives, and penetration throughout the wood is usually complete, even with an open tank treatment. Treated specimens of *semul* have lasted at Dehra Dun for many years, even though exposed to the most drastic outdoor conditions. Untreated specimens under the same conditions were completely destroyed by white ants and rot within a few weeks. *Bombax insigne* has the reputation in the Andamans of being little attacked by white ants, it is said to last for years as long as it does not get wet.

Working qualities.—*Semul* is one of the easiest Indian woods to saw and work. It planes to a good surface, but the large open pores of the wood prevent it being used for polished work. With careful filling it can, however, be used to advantage for painted work. It can also be peeled on a rotary lathe and made up into plywood, but its strength is below that of the usual commercial plywoods and it is rather weak for tea boxes although it is being used for this purpose. It is very suitable for light plywood containers where strength is not of great importance.

Uses.—*Semul*, as stated above, is put to a large variety of uses in India. It is one of the most universally used timbers for match box manufacture. It is also used for splints, but the quality of *semul* splints is well below that of aspen. Very large quantities are also consumed in box and packing case manufacture, one firm in Calcutta using as much as 300 tons per month for this purpose. It is commonly used as boarding for various purposes such as ceiling boards, and large quantities are absorbed by the tea box trade for use as inside corner supports in plywood tea boxes. If preservative treatment was more universal in India, the uses of treated *semul* could be greatly augmented. At present its perishable nature limits its utility, but if treated it could command a very wide range, including such uses as wall boards, insulation boards, shingles, and light furniture. It is used by most firms in India for plywood and makes up into good quality but rather weak tea boxes.

Sources of supply.—Except for the Punjab and Sind, *semul* is available in every Province in India. Enquiries should be

addressed to the nearest Conservator of Forests. In favourable localities logs of 6 to 8 ft. girth are not uncommon. It is common in the Andaman Islands and supplies up to 1,000 tons per annum in large cylindrical logs could be arranged for from there if required. Assam and Bengal both have good supplies available, but elsewhere the demand is always considerable and enquiries as to the best source of supply are advisable, as supplies cannot always meet the demand.

Prices.—The price of such a widely distributed wood as *semul* is bound to vary considerably from place to place. The Andamans quote Rs. 22 per ton in the log and Rs. 35 to Rs. 45 per ton for sawn scantlings (1937). Assam quotes Rs. 28 per ton in the log and Rs. 1-2 per c. ft. for 12" squares up to 36 ft. in length (1937). Bengal quotes up to Rs. 25 per ton according to quality for logs, while other Provinces quote as follows:—

Central Provinces	... Rs. 30 to Rs. 45 per ton in logs of 3 to 4 ft. girth.
Madras	... Rs. 6 to Rs. 27 per ton.
Orissa	... Rs. 19 to Rs. 40 per ton for logs up to 7 and 8 ft. girth.
Bombay	... Rs. to Rs. 70 per ton.
Bihar	... Rs. 22 to Rs. 25 per ton.
United Provinces	Up to Rs. 30 per ton according to quality.

Boswellia serrata.

Trade name.—*Salai.*

Vernacular names.—*Salai*, *kungli* (Tam).

Weight.—32 to 36 lbs. per c. ft. (air-dry).

Description of the wood.—The sapwood is usually large and of a dirty greyish-white colour. The heartwood is greenish-brown in colour, sometimes marked handsomely with darker wavy lines, but except in large trees the heartwood is not usually large enough for practical use. When the wood of *salai* is referred to, it is therefore the sapwood which is usually meant. The sapwood is extremely prone to discolouration from fungal stain and it is rare to see wood of *salai* without this discolouration which naturally restricts its sphere of utility.

Seasoning.—Since the wood of *salai* is extremely liable to rapid fungal discolouration after conversion, it is a difficult wood to air season satisfactorily. The time of year when conversion takes place is an important factor in this connection, and if possible conversion should always be done in dry weather. The timber should be open-piled immediately after sawing, in a position where a good circulation of air can blow through the stack. The sapwood is not prone to splitting or cracking, but the heartwood, on the other hand, is very refractory and difficult to season. It is best, therefore, to separate heartwood and sapwood when seasoning *salai* as the former effects the latter detrimentally. Kiln seasoning offers no difficulties and the sapwood of *salai* can be kiln dried with very little degrade. Kiln seasoning is definitely recommended for this wood.

Strength.—*Salai* has no great strength and should not be used where strength qualities are required. It is, on the other hand, stronger than semul and could be used for light construction work if treated. For details of its strength qualities see Appendix I. Ammunition boxes tested at Dehra Dun, showed greater strength than similar boxes made of teak.

Durability.—*Salai* is one of India's most perishable woods. It is a waste of time trying to use the sapwood for any purpose where a life of more than a few months is required unless it is treated. The heartwood has the reputation of being fairly durable and in the "graveyard" tests at Dehra Dun it lasted for about $3\frac{1}{2}$ years. The sapwood can be treated with preservatives without difficulty, and even an open tank treatment with a good preservative would go a long way towards increasing the utility of this wood for a variety of purposes. While green the wood is heavily attacked by borer: quick kiln drying prevents this trouble.

Working qualities.—There is nothing difficult about the sawing or working of *salai*. It is an easy wood to work, but needs careful handling to bring to a good surface. It can be polished after suitable filling. The heartwood takes an excellent polish and has a very handsome appearance, but its refractoriness in seasoning rules it out as a practical proposition.

Uses.—*Salai* has always been looked upon as a Cinderella amongst Indian woods, chiefly owing to its rapid discolouration from fungal attack which will always be a handicap to its better utilization. The best solution is quick drying and preservative treatment, and if these practices were more widely adopted in districts where the wood is common, its utility would be greatly increased. It is used at present for cheap box work, packing-cases, inferior planking, cheap furniture and sundry other requirements. It is also used for match manufacture by various factories, but its discolouration is a drawback to its more extensive use for this purpose, especially in the damp periods of the year. It has also been used for cooperage and proved satisfactory for cement barrels. It has been tested for plywood, and the tests indicate that, with care, *salai* might be used for plywood, although its liability to staining is a drawback which will need careful handling in damp localities. It is also very variable in colour. It has been tried for mechanical pulp and found suitable for certain types of cheap paper. It has saved the situation with regard to ammunition box supplies.

Sources of supply.—Supplies are abundant in the Central Provinces, Madras, Bombay, Bihar, Orissa, and the Jhansi Division of the United Provinces. It is a very common tree in some of the drier forests of Central India and logs up to 6 ft. in girth are available in some areas, but logs below 5 ft. in girth are usually more common. It occurs in almost pure stands in some localities and large annual supplies would be forthcoming if there was a demand for it. The Nimar forests of the Central Provinces and the East Khandesh Division of Bombay Province could probably supply well over 5,000 tons per annum if the demand arose. It is one of the trees for which more extended markets are required, and by proper seasoning and preservative treatment this end could probably be attained with a little organisation.

The fact that sustained supplies, on a large scale, are available is one of the main points in favor of this timber.

Prices.—At present the supply is considerably greater than the demand for this timber, and prices are therefore on the low side, ranging from Rs. 19 to Rs. 22 per ton in Bihar to Rs. 25 to Rs. 40 per ton in the Central Provinces and Madras (1937), according to quality and size. In some Divisions, supplies would

be forthcoming at 2 to 4 annas per c. ft. Enquiries should be addressed to the nearest Conservator of Forests of the Provinces mentioned above.

Bridelia retusa.

Trade name.—This species has no official trade name.

Vernacular names.—*Khaja*, *Kashi*, *Kassi*, etc. In Burma *Seikchi*.

Weight.—36 to 47 lbs. per c. ft. (air-dry).

Description of the wood.—A dull drab or brown wood, sometimes with lighter bands due to interlocked fibres. Fairly even textured, and moderately heavy. Described by H. P. Brown as "a good utilitarian timber of the second class".

Seasoning.—It seasons with difficulty and appears to be subject to serious defects when drying. It should be converted green and the sawn material should be stacked in close piles as for other refractory woods.

Strength.—It can be described as a moderately heavy and hard wood about 20 per cent weaker than teak. For details of its strength values compared to those of teak, see Appendix I.

Durability.—This timber has the reputation of being durable, and, as it is recorded by Rodger as being a favourite wood for house posts in Burma, it is probably above the average for durability, but no official tests appear to have been done on it.

Working qualities.—It saws and machines easily and can be worked without difficulty to a smooth finish. It is a fairly close-grained wood and is probably, therefore, suitable for turnery and carving. It has not been tested for veneers for plywood but it is probably rather too hard and heavy for the purpose.

Uses.—This wood is one of the numerous timbers of India which are used in fair quantities locally where they occur, but in which there is no extensive trade otherwise. It is used locally for house-posts, rafters, floor boards and other domestic purposes. It is also used for country carts and agricultural implements. As it is a species which is widely distributed but never found in any large quantities in one place, it will probably never enjoy anything better than a local demand, but with preservative treatment it might be turned into an excellent constructional wood for local purposes.

Sources of supply.—Bombay, Bengal, Bihar and Orissa all quote this wood as being available in commercial quantities. In some Divisions of Central India it is a fairly common tree and moderate supplies could always be arranged if any demand arose. Enquires should be addressed to the conservators of Forests of the Provinces concerned.

Prices.—Bengal quotes Rs. 19 to Rs. 31 per ton from Chittagong. Bihar quotes Rs. 22 to Rs. 25 per ton in log form. The Bombay prices range from Rs. 9 to Rs. 35 per ton and Orissa quotes Rs. 19 per ton. The maximum girth of average parcels would probably be about 5 ft.

Buchanania latifolia.

Trade name.—No official trade name.

Vernacular names.—*Piyal, chiroli, chironji*, etc.

Weight.—About 29 lbs. per c. ft. (air-dry).

Description of the wood.—An uninteresting dull grey or greyish-brown wood, some times with a yellowish tinge, and frequently discoloured by fungal stain to which it is very subject. It is a very light straight-grained wood but has a coarse texture, and is rough to the feel.

Seasoning.—This wood presents no difficulty as regards seasoning, but being extremely prone to rapid fungus attack when green, it should be dried quickly after conversion. Stacking in open piles under cover with a good air-circulation through the stacks would probably suffice to dry the timber in a fairly clean condition. It is a non-refractory wood and has the reputation of seasoning well without degrade.

Strength.—Although this wood has not been subjected to the standard strength tests at Dehra Dun, it is reported to be moderately strong in relation to its light weight. As it is used locally for bedsteads and building purposes, it is obviously not a very weak wood, but it cannot be classed amongst the better quality constructional timbers.

Durability.—It cannot be classed as a very durable wood, and it is obviously one which should not be used for any important purpose without preservative treatment. As it has large open pores, it is probably an easy subject for treatment, but it is not a timber which has been subjected to any official wood preservation tests.

Working qualities.—An easy wood to saw and work to a moderate finish. It has not been tested for veneers or plywood work, but it has been reported on by a match factory in Belgaum as suitable for match manufacture.

Uses—This wood is one of the so-called "jungle-woods" which are found fairly widely distributed throughout many parts of India, but which are not used to any large extent except for local domestic purposes. As it is a species which is often found in considerable quantities in some localities, and one for which an extended market is wanted, it would be worthwhile investigating its possibilities after preservative treatment. Many of these common but little used woods can be turned into extremely useful

building timbers once they are properly treated with a good preservative.

Sources of supply.—Fairly large supplies could be obtained from Bombay, the Central Provinces, Bihar, Orissa, the United Provinces and Madras where dry types of forest exist. Large logs would not be forthcoming, however, as it is a smallish tree, usually with a 2 to 3 ft. girth stem and not much above 8 ft of clear bole. Enquiries should be addressed to the nearest Conservator of Forests of the above mentioned Provinces.

Prices.—The prices of this wood are never likely to rise very high on account of the small size of timber available. Bombay quotes Rs. 25 to Rs. 35 per ton, and Orissa quotes Rs. 19 per ton (1937). Other Provinces would probably be glad to supply at an equally low price.

Calophyllum species

(*Calophyllum tomentosum, Calophyllum inophyllum*), (*Calophyllum spectabile, Calophyllum wightianum*).

Trade name.—*Poon.*

Vernacular names.—*Pantaga, wuma, punnal, lalchini, ponnyet* (And.), *kamdeb* (Beng.) In Burma *C. inophyllum* = *paungnyit* or *ponnyet* and *C. spectabile* = *pantaga.*

Weight.—41 to 48 lbs. per c. ft. (air-dry).

Description of the wood.—The woods of all the Indian species of *Calophyllums* are very similar in appearance. They are of a pale reddish-brown colour with characteristic darker streaks showing up on all tangentially or radially cut surfaces. When this bold grain effect is in evidence *poon* woods can be classed as ornamental. In other respects they are excellent strong constructional timbers, and as good long lengths are usually available, they are useful woods for many purposes where other timbers are ruled out on the score of having short marketable boles. The *poons* are, of course, already well known in timber circles in India, and the name "poonspar" was derived from the fact that fine spars for the ship-building trade were obtained from this species in the days of wooden vessels.

Pearson, however, records the fact that only a small percentage of the timber available is straight-grained, the remainder having heavily interlocked fibres in broad bands.

Seasoning.—None of the *poon* woods offer any great difficulty as regards seasoning, and if stacked properly with crossers under cover the timber should dry out fairly quickly without degrade if conditions are favourable. *Calophylluin wightianum* has the reputation of being slightly more refractory than the others and with a tendency to surface cracking, but if reasonable care is taken, the degrade should not be very severe. Some of these woods are liable to attack in log form by borer beetles, and it it is advisable, therefore, to de-bark the logs soon after felling.

Strength.—Two species of *poon* from Bombay Province, and one from Madras have been subjected to the standard strength tests at Dehra Dun, and the strength figures are recorded in Appendix I. They are all hard strong woods, ranging, on the average, a little below teak in strength. *Calophyllum wightianum* is 10 per cent harder than teak but of the same weight. The others are, on the average, slightly lighter than teak and of about equal hardness. It is strange that the recorded figures of strength do not give a true picture of the excellence of this timber for masts and spars.

Durability.—The *poons* are all moderately durable woods and, in dry positions, will last a number of years. For outdoor work or in contact with the ground they should, preferably, be treated. In the "graveyard" tests at Dehra Dun, they lasted on an average for about 6 years. The sapwood treats readily but the heartwood is not easily penetrated even under pressure. If *poon* timber is to be used treated, therefore, as much sapwood as possible should be included.

Working qualities.—*Poon* wood is an easy wood to saw and work, and straight-grained wood can be brought easily to a fine surface. If broad-bands of interlocked fibres are present in the timber, a little more care and sharp tools are necessary to bring it to a good finish. Once finished, they are good timbers for polishing. Both *Calophyllum tomentosum* and *Calophyllum wightianum* were tested at Dehra Dun for rotary cut veneers and plywood, but they did not prove to be very good subjects for the purpose. The cross-banded fibres, and a liability to fine hair checks in the finished panels were the chief drawbacks. Sawn veneers, on the other hand, were made up into some extremely handsome panels without any difficulty and these have remained in excellent condition for the past 16 years.

Uses.—The *poons*, classified together, form a valuable range of structural timbers of the first class. They are available in fair quantities and, being strong for their weight, they are worthy of the notice of engineers and architects. As ornamental woods they cannot rank with such timbers as figured laurel and *sissoo*, but with careful selection, it is often possible to pick out from any stock a good parcel of ornamental planks, and if a fair quantity of wood with dark streaks is present a fine selection of panels can be procured.

Source of supply.—The chief source of supply of *poon* wood is in south India, from the West Coast district of Coorg. *Calophyllum spectabile*, on the other hand, is available only from the Andamans in limited quantities, while Bengal can supply a small quantity of *poon* from Chittagong.

Enquiries should be addressed to the Chief Conservators of Forests, Madras and Bombay, to the Chief Forest Officer, Coorg or the Chief Forest Officer, Andaman Islands.

Prices.—Bombay quotes *poon (Calophyllum tomentosum)* at Rs. 44 per ton in log form, while Bengal quotes Rs. 31 to Rs. 41 per ton for timber from Chittagong (1937).

Canarium species.

(Canarium euphyllum, Canarium bengalense, Canarium strictum).

Trade name.—Dhup. Sometimes called Indian white mahogany and also white *dhup.*

Vernacular names.—Dhup, kunthirikkam (Mal.), *dhupa, goguldhup*, etc.

Weight.—Canarium euphyllum, 26 to 30 lbs. per c. ft.; *Canarium bengalense*, 19 lbs. per c. ft., and *Canarium strictum*, 38 lbs. per c. ft.

Description of the wood.—The *dhup* woods are usually a creamy white colour, but may have a pinkish-grey or yellowish tint. They are rather prone to discolouration from sap-stain but, nevertheless, they are extremely valuable woods from the commercial point of view, because they are available in large quantities. This is especially so in the case of *Canarium euphyllum*, the Andaman *dhup*, which supplies one of India's greatest needs, namely a good light-weight white wood for the match box and box-making trades. The West Coast, Bengal and Assam supplies of *dhup* are unfortunately limited, but where they occur their value is already recognised.

Seasoning.—The *dhup* woods are non-refractory woods from the seasoning point of view, and if properly looked after can be dried with very little deterioration. They are, however, very prone to discolouration from mould and fungus attack, and are also liable to insect attack in the green state. They should, therefore, be dried quickly after conversion, and all bark should be removed if logs have to be stored. Vertical stacking (as for *semul*) is probably the best method to adopt if air-seasoning is unavoidable, but kiln-seasoning is the best procedure for drying this type of wood if it can possibly be managed. In localities where a moist atmosphere is the rule for the greater part of the year, it is well-nigh impossible to dry quick-staining woods satisfactorily without a seasoning kiln, and if the output is of any quantity, the installation of kilns is a commercial asset.

Strength.—Canarium strictum is the heaviest and hardest of the *dhups*, and it can be described as a moderately strong wood. Andaman *dhup*, on the other hand, has less than half the hardness of teak and about 50 to 60 per cent the strength of teak. The value of Andaman *dhup* does not, however, lie in its strength qualities, but in the fact that it is a good clean soft white wood in plentiful supply of a type which India sadly lacks. Tests on plywood tea boxes made of *Canarium strictum*, on the other hand,

were most encouraging, and boxes made of this wood proved to be amongst the strongest tea boxes ever tested at Dehra Dun. Only a very few tests have been done on *Canarium bengalense*. These indicate that it may be stronger than the other two.

Durability.—None of the *dhup* woods can be described as very durable woods. They are all very prone to attack by moulds, discolouration, decay and insects. Rapid drying immediately after conversion will ward off most of these troubles, but if *dhup* is to be used for any work where durability is required, preservative treatment would be essential. They can be treated with comparative ease, as has been proved by actual tests, and when treated they last remarkably well.

Working qualities.—The *dhups* are amongst the easiest of Indian woods to saw, work, and bring to a good finish, and they present no difficulties in this respect. The South Indian *dhup* (*Canarium strictum*) when tested at Dehra Dun for plywood manufacture proved to be very amenable to peeling on a rotary lathe, and had every indication of being an excellent 3-ply wood. The veneers came off the lathe in good tight sheets and behaved most satisfactorily under the drying and gluing processes. The plywood, when made up, had an excellent appearance and was entirely free of any detrimental defects.

Uses.—The main market for the Andamans *dhup*, at present, is for match box manufacture in and around Calcutta and Madras. It gives India's second best quality match box, *lambapath* (*Siderascylon longepetiolatum*) being the best in India and one of the world's finest match box timbers. The South Indian dhup is used for packing case work and for interiors and backings in the furniture trade.

Sources of supply.—The main source of supply of *dhup* wood is from the Andamans which can produce 10,000 tons per annum. The greater part of this supply is, however, already taken up by the match and packing case trades. Bengal and Assam can produce only small quantities between them, while the West Coast and Coorg can also produce a limited quality. Enquiries should be addressed to the Chief Forest Officer, Port Blair, Andamans Islands or to the Conservators of the other Provinces concerned.

Prices.—The prices of Andamans *dhup* are quoted as Rs. 27-8 per ton in log form, Rs. 36 to Rs. 40 per ton in sawn squares, and Rs. 40 to Rs. 45 per ton for scantlings (1937).

Assam quotes Rs. 37-8 per ton for logs up to 18 ft. in length and up to 5 ft. in girth, and Rs. 1-4 per c. ft. for $12'' \times 12''$ squares of the same length. Bengal quotes Rs. 18 to Rs. 25 per ton for logs from Buxa Division.

Carapa moluccensis.

Trade name.—Pussur.

Vernacular name.—Pussur. Known as *kyana* in Burma.

Weight.—About 49 lbs. per c. ft. (air dry).

Description of the wood.—A fine even-textured cabinet wood of a pleasant brownish-red colour which sometimes tones down to a good clear brown on exposure. More often the wood retains its mahogany red colour. Darker streaks are not uncommon. When finished to a good surface the wood has an extremely smooth feel. It is a moderately heavy wood and is remarkably steady once it has been seasoned. It is described by Scott as being the nearest approach among Burma woods to true mahogany, and being of the *Meliaceae* it is of course closely allied to the mahoganies.

Seasoning.—The timber is not a difficult one to season. There is sometimes a tendency to warp in the wider planks, but this can usually be overcome if care and attention is paid to the stacking. It responds fairly readily to air-seasoning, and has been kiln-seasoned experimentally and commercially without difficulty.

It is liable to the formation of moisture pockets, hence slow drying is essential. (Kapur and Rehman).

Strength.—Pussur is a fairly heavy wood and is 15 per cent heavier than teak. It is also harder than teak. In other strength qualities it is about equal to teak. The details of its strength functions can be seen in Appendix I.

Durability.—As far as is known, *pussur* is a fairly durable wood, but no reliable records as to its exact behaviour in this respect are traceable. In the "graveyard" tests at Dehra Dun five out of the six specimens under test were in excellent condition after 3 years, while the sixth specimen had been destroyed by white ants. It was used for a parquet floor in the Board Room of the Forest Research Institute about 10 years ago, and so far has shown no signs of wear and tear or damage from insects or rot.

Working qualities.—This timber saws easily enough and, at Dehra Dun, no difficulty has been experienced with it in working it and bringing it to a fine finish. Being a fine and even textured wood it can be finished to an extremely smooth surface, and can be readily polished, but a wax finish really suits it better than high polishing. It is very steady when made up into furniture and, having an attractive colour and grain, it can, therefore, be classified as a first class cabinet wood.

Uses.—Uptill a few years ago, *pussur* was in India an almost unknown, and certainly little used, wood although it was fairly well known in Burma. Of recent years, it has been exploited as a furniture wood, and was selected by a large firm of gramophone and wireless makers in Calcutta as suitable for making gramophone and wireless cabinets. Later, this same firm complained that a large percentage of the wood contained knots and curious blemishes which they described as black spots. The same defects were also reported from Burma, where it was being used for cabinet making. These defects had not been experienced in the wood received at Dehra Dun, but they may be noted as existing and may tend to reduce the utility of this otherwise excellent timber.

Sources of supply.—The only source of supply in India is Bengal. The tree is one found only in mangrove forests, and limited supplies can be obtained from the Bengal Sunderbans. If large supplies are required they would have to be obtained from Burma, where up to 500 tons per annum could be made available for export if required.

Prices.—Bengal quotes Rs. 25 to Rs. 30 per ton for logs (1937). The Burma price would be higher but the average girth of logs from Burma would probably be from 4 to 5 ft. whereas the Bengal supplies are of smaller dimensions.

Castanopsis hystrix.

Trade name.—Indian chestnut.

Vernacular names.—*Katus, kingori* (Ass.)

Weight.—About 42 lb. per c. ft. (air-dry).

Description of the wood.—A creamy-grey or creamy-brown wood. Rather rough to the feel and uneven-textured, but a very sound timber and one which is recognised as the best of the hill oaks and chestnuts of Northen Bengal. If it occurred near any large manufacturing centre it would probably be extensively used.

Seasoning.—The recorded opinions of those having experience of this wood, indicate that it is a not very refractory timber. Shebbeare reports that it is often used in a green state in the hills of Bengal, and of 200 sleepers sent to Dehra Dun, only those with heart centres showed any bad tendency to split. Kapur describes it as moderately refractory, and says that it is subject to some slight surface and end-cracking. A worse defect seems to be its liability to decay and insect attack, and for this reason it should be converted, if possible, in dry weather and dried under cover in open stacks. It dries quickly, and 6 months seasoning of 1-inch stock is sufficient to bring it down to a low moisture content.

Strength.—Indian chestnut is a moderately strong wood, being about 25 to 30 per cent weaker than teak according to some strength tests done at the Civil Engineering College at Sibpur. It has been passed as suitable for sleepers, from the strength point of view. For details of its strength functions, see appendix I.

Durability.—According to local observers in Bengal, this wood is above the average in the matter of durability but, as it is prone to incipient decay, it would be far safer to use it after treatment with a preservative if good durability is required. It lasted only for 4 years as an untreated sleeper, and about 3 years in the "graveyard" tests at Dehra Dun. It takes preservatives fairly readily, and some sleepers sent to Dehra Dun for test absorbed 10 lbs. of creosote per c. ft. without any difficulty. Penetration in the sapwood was complete and in the heartwood good but erratic.

Working qualities.—Indian chestnut offers no difficulties as regards sawing and working to a good finish. It has a slight resemblance to oak in appearance but the rays are not so conspicuous. It has not been tried for veneers or plywood. Pearson says it is easily cleft and Brown classifies it as a timber of the first class.

Uses.—It is used fairly extensively in the hill districts of Bengal, where it grows, as a domestic constructional wood and is commonly employed for shingles. It makes a treated sleeper of fair quality, and would, after proper preservative treatment, probably make a first class constructional and interior building timber. It should also prove useful for furniture making, and possible for veneer work although it has not, so far as is known, been tested for this purpose.

Sources of supply.—Supplies in fair quantities are available in the Darjeeling, Kurseong and Kalimpong Divisions of Bengal, and in more limited quantities from Assam. It is comparatively common round Darjeeling and Kalimpong. Logs up to about 4 to 5 ft. girth are usually obtainable,

Prices.—Bengal quotes Rs. 80 per ton for sawn squares, and for scantlings 14 to 17 annas per c. ft. Assam quotes Rs. 37-8 per ton for logs and Rs. 1-4 per c. ft. for squares of 18" sidings and 18 ft. length (1937).

Cedrela species.

(Cedrela toona, Cedrela microcarpa and *Cedrela serrata)*

Trade name.—Toon. Cedrela serrata is known as hill *toon.*

Vernacular names.—Tun, tuni, poma, noga, (Coorg), *chukkanagil* (Mal.), etc. Sometimes known as red cedar or Moulmein cedar. In Burma *C. toona = thitkado C. serrata = taungdama.*

Weight.—About 30 to 37 lbs. per c. ft. (air-dry).

Description of the wood.—The wood is a pinkish brick-red, when freshly cut, toning to a light brownish red on exposure. It is very similar in appearance to the wood of an ordinary cigar box. Darker streaks are sometimes prominent, due to the different texture of the spring and summer wood of the growth rings. This difference in the colouration of the growth rings shows up well on rotary cut veneers. In other respects the wood is a light-weight, and usually straight-grained timber, but curly grain is sometimes encountered and good "figured" veneers and boards can be cut from such stock. The wood has a distinct cedar like smell, but this is inclined to fade on exposure.

Seasoning.—Toon is a fairly easy wood to air season if care is taken with the stacking. Green conversion is advocated, and the converted material should be stacked carefully under cover with crossers. Boards up to 2 inches thick, and scantlings up to 3" × 3", will air-season thoroughly in about 12 months under average conditions. Conversion during dry weather is recommended if possible. During seasoning, the timber is sometimes inclined to warp and collapse. Warping can usually be prevented by careful stacking, and collapse can be removed by steaming at 100°C. for 2 to 6 hours. *Toon* shrinks considerably when seasoning, and even when dry it is inclined to expand and contract with variations of the surrounding atmospheric conditions. A 3 per cent clearance should therefore be allowed for this wood when framing up stock. The kiln-seasoning of *toon* offers no difficulties beyond a possibility of collapse which can be removed by steaming.

Strength.—Toon is a timber of only moderate strength qualities, except in the matter of shear in which it is equal to teak. In other respects it has only about 60 per cent the strength of teak. Hill *toon* (*Cedrela serrata*) is stronger and has about 80 per cent the strength of teak. Strength figures for both *Cedrela toona* and *Cedrela serrata* are available and can be seen in Appendix I.

Durability.—Seasoned *toon* has the reputation of being a fairly durable wood. It is, however, inclined to rot if left in log

form for long, and white ants will attack logs if the bark is not removed. Otherwise, in a seasoned condition, it is fairly durable under cover. In the "graveyard" tests at Dehra Dun it lasted for about 4 years. Preservative treatment is recommended if a long life is required. Treatment of the heartwood is difficult and erratic. The sapwood is readily treatable.

Working qualities.—Toon is one of the easiest of Indian woods to saw and work. If properly finished and filled, it takes a very good polish. Its liability to expand and contract with changing atmospheric conditions, has already been mentioned above, and allowance for this not uncommon feature of woods in India must be made when framing up. It is very amenable to rotary peeling, and can be peeled green without any soaking treatment, unless logs have been in store a long time when boiling is advisable. It makes up into a good type of plywood of a semi-ornamental nature. It makes high quality compregnated wood.

Uses.—Toon is probably the most commonly used "bazaar" furniture wood in India. Being cheap, light, easy to work, and quickly seasoned, it lends itself for use in small workshops. It cannot, however, be ranked amongst the best of india's furniture woods, as it is inclined to dull with age and lose its character unless kept in good condition. It is, however, excellent for linings and backings. Besides furniture, it is used for domestic building purposes, tea-boxes, cigar-boxes, toys and carvings. If treated, it would make a most excellent light building wood, and it has been much used for plywood in the present war.

Sources of supply.—Toon wood is available in most of the plains and sub-Himalayan tracts of india. It is usually a scattered tree, but is also one extensively planted along roads and round villages. It is, therefore, usually obtainable in good girth logs from the nearest bazaar or timber merchant. It is, generally speaking, more common in North India than in the South, but Assam and Bengal have fair supplies, drawn, as in the United Provinces, partly from forests but more frequently from other sources. *Cedrela microcarpa* is obtainable only in limited quantities from the Darjeeling Division of Bengal, and *Cedrela serrata* is hardly a commercial proposition, being available only in small quantities in hill districts such as Hazara, Jaunsar and Tehri-Garhwal.

Prices.—The United Provinces quote Rs. 15 to Rs. 35 per ton for logs from Bahraich Division. The Central Provinces quote Rs. 62 per ton for logs, Bengal Rs. 35 to Rs. 45 per ton for logs of 5 ft. girth and Rs. 1-8 per c. ft. for squares 18 ft. in length and with 12" sidings (1937).

Cedrus deodara.

Trade name.—Deodar. Sometimes called Indian or Himalayan cedar.

Vernacular names.—*Paludar*, *diar*, *devidar*, etc.

Weight.—About 35 lbs. per c. ft. (air-dry).

Description of the wood.—Deodar hardly needs any description in India. Its light yellow-brown colour and distinctive odour are usually well known to timber merchants, especially in Northern India. It is a medium weight wood which is very "steady" in use, and being durable and in plentiful supply, is the most important commercial timber of the Punjab. It is usually even-grained and of medium to fine texture, but the presence of large knots is a common feature and this detracts from its value as a clean carpentry wood..

Seasoning.—Deodar is an easy wood to air-season. It may suffer a little in seasoning from surface-cracks and some splitting, if dried too quickly, and is best seasoned under cover, but on the whole deodar gives very little trouble. It can also be kiln-seasoned easily without degrade. The wood contains a volatile oil (from 3 to 10 per cent of the weight of the dry wood) and this effects moisture content readings by the ordinary oven-drying method, unless allowed for. For example, a moisture content reading may show 18 per cent of water and 8 per cent of deodar oil.

Strength.—Deodar is the strongest of the Indian conifers. Its weight is 20 per cent less than teak and its strength is also about 20 per cent less. Weight for weight, therefore, it is about the same strength as teak. It is reasonably hard for its weight, being 70 per cent the hardness of teak.

For the details of its strength qualities reference should be made to Appendix I.

Durability.—The seasoned heartwood of deodar is naturally durable, but it is by no means unknown for deodar heartwood to be attacked by termites and fungi. In the "graveyard" tests at Dehra Dun all six specimens under test were still in place after 6 years, but they had all been attacked to quite a considerable degree by white ants. The sapwood is not durable, and the North Western Railway now treats all its deodar sleepers whether they contain sapwood or not. It treats fairly readily, but penetration is erratic. Sometimes the sapwood absorbs preservative well, while at other times the penetration and absorption are poor.

Working qualities.—Deodar is an easy timber to saw and work to a smooth finish. It is not, however, a suitable wood for polish

or paint work as the oil in the wood, and especially near knots, always seeps through such finishes and discolours them. It has been tried for rotary-cut veneers and plywood, but the large hard knots, so common in deodar, make it unsuitable for this purpose. Its large knots would certainly be against it for commercial plywood work.

Uses.—The primary use of deodar at present, is for railway sleepers and construction work. It is extracted mainly in sleeper form and these sleepers, if surplus to railway requirements, are further converted into scantlings and boards for house-building, furniture and other purposes. A certain number of logs are also extracted, more especially from Kashmir and Chamba State. It is by far the most important wood of the Punjab and North India and is eminently suitable for structural work of all kinds, for beams, floor boards, posts, window frames, light furniture and shingles. The railways use it for carriage and wagon work and the Ordnance Department uses it for boxes. It is too tough for pencil-making, but it makes an excellent pattern wood, being very steady if well seasoned.

Sources of supply.—Deodar is available mostly in sleeper form, chiefly in the 10′ × 10″ × 5″ size, from all the Punjab timber depots at Jhelum, Wazirabad, Lahore, Dhilwan, Doraha and Jagadhri. It is also brought down the Indus and Kabul rivers to Nowshera in the North-West Frontier Province. Logs and other sizes of sleepers and scantlings are also obtainable at some depots. Very large quantities are available, estimated at over 5 million cubic feet per annum.

Prices.—Deodar prices are inclined to fluctuate according to Railway requirements and the state of the market. The Punjab quotes Rs. 1-2-6 to Rs. 1-7 per c. ft. for sawn material according to quality and size (1937), but an enquiry to the Chief Conservator of Forests of the Punjab or the United Provinces, or to any North Indian timber depot, will at once result in current quotations being forthcoming.

Chukrasia tabularis.

Trade name.—Chickrassi.—The name golden mahogany has been used by Burma.

Vernacular names.—Chikrassi, boga-poma (Assam), *karaḍi* (Coorg), *yinma* (Burma).

Weight.—About 40 to 42 lbs. per c. ft. (air-dry).

Description of the wood.—When freshly cut *chickrassy* is pale buff colour, but this soon changes to a golden-brown on exposure. Sometimes the buff colour has a slight pinkish or reddish tint. It is a lustrous wood of medium weight and it not infrequently has a good "figure" in its grain. This figure may be of the fiddle-back type, or may be due solely to the darker coloured annual growth rings. It is a good quality wood of cabinet-making standard.

Seasoning.—An easy wood to air-season and one falling in the non-refractory category. Logs should be converted green and the sawn material stacked in open piles under cover. About 6 months, under average conditions, would be sufficient to air-dry 2" material. In veneer form the wood has a tendency to develop fine surface hair cracks, but this defect has not been noticed in the solid wood. Kiln seasoning presents no difficulties but Burma reports that it is advisable to start the drying with not too severe conditions in order to avoid any possibility of collapse.

Strength.—Chickrassi is about the same weight as teak and is slightly harder and stronger in shearing strength than teak. In other respects it is about 20 per cent. weaker than teak. The timber has been subjected to the full standard tests, and details of its strength qualities will be found in Appendix I.

Durability.—Chickrassy cannot be classed as a durable timber in contact with the ground or in outdoor situations, but under cover it is a timber of moderate durability. In the Dehra Dun "graveyard" tests, the six specimens under test were destroyed within 5 years. If used as a structural wood it should be treated, but as it falls under the heading of a cabinet wood its natural durability is sufficient for the uses to which it will usually be put. It has lasted well in the form of untreated plywood panelling in the Allahabad Bank at Dehra Dun. The timber is difficult to treat in the heartwood.

Working qualities.—This wood offers no difficulties as regards sawing and working. It can also be easily turned and carved and can be brought to a fine finish. It takes polish excellently

but should be allowed to tone down to a good colour before polishing is done. It can be peeled on a rotary lathe without any difficulty, either green, or after soaking if the logs have been in store. It makes up into good plywood boards, the average run being suitable for general purpose plywood, but selected figured boards are extremely handsome and suitable for the finest cabinet work or panelling. One or two logs of this timber received at Dehra Dun have rendered figured wood of a type ranking with the finest veneer woods of the world.

Uses.—An average parcel of *chickrassy* would probably be composed of logs producing sound useful furniture wood, but there is always the chance that a finely figured log may be included. The Burma supplies appear to have a better percentage of figured wood than those from Bengal and Assam, but if figured logs are received they should be treated with respect and utilized only for ornamental work. Figured wood of this type will always command a very good price from cabinet makers. Locally, where the timber grows, it is used for furniture making and for domestic construction and house building for which it is very suitable. It is extremely steady once it has been seasoned, and for this reason it will always be popular. It is being tested for laminated air craft propellors.

Sources of supply,—The only two sources of supply in India are Bengal and Assam. Good size logs of cylindrical shape are usually available. The Bengal supply is drawn from Kurseong, Buxa, and Chittagong Divisions. Application should be made to the Forest Utilization Officer of Bengal or to the Forest Utilization Officer of Assam.

Prices.—Bengal quotes Rs. 25 to Rs. 35 per ton in the log. Assam estimates Rs. 45 per ton for logs 24 ft. long by 5 ft. girth, and Rs. 1-8-0 per c. ft. for sawn squares of 15 inch sidings.

Cinnamomum cecidodaphne.

(Including also *Cinnamomum glanduliferum.*)

Trade name.—Cinnamon.

Vernacular names.—Rohu, gondhori, malagiri (Nep.), *Unanthin* (Burma).

Weight.—About 36 lbs. per c. ft.

Description of the wood.—A greyish-buff or light-brown wood of medium weight and medium texture. When freshly cut the wood has a strong smell of camphor which is retained by the wood for a long time. Pearson quotes a case of a piece of this wood still retaining its scent after 40 years. It is a sound wood of good quality, not outstandingly handsome but often with some darker coloured ring figuring. Ii is well-known and sought after locally where it grows, and owing to this local demand in the past it is now not very plentiful, but plantations have been started and small parcels can be supplied on demand.

Seasoning.—It is recorded as being an easy wood to season, though it is not a wood which has been subjected to any official seasoning tests. Judging by its local popularity, it is probably a non-refractory wood, and a 2 ft. wide plank at Dehra Dun has certainly remained entirely free from any cracks or other faults for 12 years.

Strength.—No official strength figures are available for this wood. According to Pearson it is a moderately hard and moderately strong wood, but details of its actual strength qualities are not known. A forest bungalow was built of it in Bengal some 30 years ago, and it is used locally for superstructures, so it must possess fairly good strength. It has also been used by the Assam Bengal Railway for carriage construction, which again indicates that it has good strength properties.

Durability.—It has the reputation of being a very durable wood even in exposed positions. This is probably due to the strong-smelling oil it contains which preserves it from attacks of insects and fungi. The above mentioned forest bungalow having lasted 30 years in Bengal is an indication that the wood of *Cinnamomum cecidodaphne* is above the average in durability. In the Dehra Dun "graveyard" tests it did not, however, do very well. All the test specimens were destroyed by white ants and fungi within 4 years. It can be treated with preservatives without difficulty if such treatment is required.

Working qualities.—An easy wood to saw and work to a fine smooth finish. It also takes polish well and can be used for

turnery and carving. It has the reputation of being one of the best furniture and carpentry woods of Bengal, and wardrobes and chests made of it are popular on account of the camphor-like scent which keeps off insects. It is certainly a good quality timber of nice appearance and feel. It has not been tried for veneers or plywood, but judging by the way it works and finishes it would probably be suitable for both purposes.

Uses.—The wood is used locally for furniture making, and as building and flooring timber. It is probably wasted on the latter uses, as its camphor-like scent and good appearance are qnalities which should be put to better uses. It is not unlike the camphor wood used by the Japanese for their famous carved camphor wood chests, and it is eminently suited for making furniture, and more especially such articles as ward-robes and chests-of-drawers, in which its scent and preservative qualities would be used to advantage.

Sources of supply.—Unfortunately supplies are limited owing to the constant local demand and the fact that the wood has been considerably exploited in the past. Assam can, however, supply moderate quantities in good size logs, and Bengal can also supply small quantities from Buxa, Kalimpong, and Chittagong Divisions. Enquiries should be made to the Forest Utilization Officers of these two Provinces.

Prices.—Assam quotes Rs. 45 per ton for logs, and Rs. 1-8-0 per c. ft. for squares up to 24 ft. in length and of 15″ sidings. Bengal estimates Rs. 25 to Rs. 35 per ton for logs and Rs. 75 to Rs. 100 per ton for sawn material (1937).

Cupressus torulosa.

Trade name.—Cypress.

Vernacular uames.—*Surai*, *devidar*, *leuri*, etc.

Weight.—About 30 to 32 lbs, per c. ft. (air-dry).

Description of the wood.—Cypress wood is undoubtedly the best conifer wood which India possesses. It is not unlike deodar in appearance but it does not have the distinctive smell of deodar. It is usually much freer from large knots than the other Indian conifers and is very straight-grained and even-textured. It is extremely durable and is altogether a very valuable wood of fine quality.

Seasoning.—Cypress presents no difficulties as regards seasoning. It is a non-refractory wood and, if sleepers or converted material are dried in open stacks under cover, the timber will season without any appreciable degrade.

Strength.—In transverse strength cypress is about 10 per cent below deodar. In hardness the two woods are much the same, although cypress is slightly lighter in weight. Details of its strength qualities will be found in Appendix I.

Durability.—In a test on the durability of sleepers of various species conducted by Gamble at Dehra Dun, cypress proved to be the best of all the woods tested. It is undoubtedly a naturally durable wood, lasting for 14 or 15 years as a sleeper in the track. Under cover it would have a very long life.

Working qualities.—Cypress is an easy wood to saw and work. It also finishes to a smooth clean surface and is a very "steady" wood. It is a popular wood in any workshops and is comparable with the best of the American or European conifers. It also has the further advantage over deodar in that it does not exude any oil, and it can therefore be painted or polished.

Uses.—Cypress is well known in the localities where it grows. It is used by the local inhabitants for bridge building, house construction and furniture. It is brought down to the plains in the form of sleepers and is used for the same purposes as deodar is used for. Frequently it is mixed indiscriminately with deodar. It is a first-class house construction and furniture wood, and it is possible that it might be suitable for aircraft work, as it is usually fairly free from knots and has an excellent straight grain and even texture.

Sources of supply.—Formerly, cypress was hardly considered to be a commercial timber of any importance, as supplies were scattered and local, but recently the United Provinces have reported that about 15,000 c. ft. is the average annual output from Kumaon Circle. This supply is probably irregular. Smaller irregular supplies are available from some Punjab hill divisions, from Chakrata Division in the United Provinces and from Tehri-Garhwal.

Prices.—The United Provinces quote Rs. 45 to Rs. 60 per ton in sizes up to 12′ × 10″ × 6″ (1937). Other quotations average about Rs. 1-2-0 per c. ft. in sleeper sizes.

Cynometra polyandra.

Trade name.—Ping.

Vernacular name.—Ping.

Weight.—About 56 lbs. per c. ft.

Description of the wood.—A heavy, hard and strong timber of Assam. The wood is greyish red in colour, not infrequently with darker markings, but it is more of a constructional type than a furniture or ornamental wood. Pearson records seeing a very handsome plywood board of this wood in Calcutta, the figure being due to wavy grain, but it is doubtful if it can be classed as an ornamental timber.

Seasoning.—Reputed to be a difficult wood to season with a tendency to bad splitting.

The drying of $2\frac{1}{2}'' \times 2\frac{1}{2}''$ scantlings of *ping* showed that the timber was slow to dry and had a tendency to splitting. Slow seasoning and protection from sun and hot winds are recommended. (Rehman).

Strength.—A very hard and strong timber. It is twice as hard as teak, and stronger than teak under all headings. Details of its strength qualities can be seen in Appendix I.

Durability.—It is not a very durable timber in exposed positions despite its hardness. Untreated test specimens lasted less than 3 years in the "graveyard" tests at Dehra Dun. It absorbs, on an average, about 7 lbs of preservative per c. ft. under pressure, with good penetration.

Working qualities.—It is rather hard for sawing and working but it can be brought to a beautiful smooth finish. Pearson records that it can be peeled on a rotary lathe without difficulty, but its hardness and tendency to split would probably rule it out for plywood work.

Uses.—It is not a timber which is used much locally, probably on account of its hardness and tendency to split. In addition, it is not very durable untreated. It was tried experimentally for treated sleepers and this may be an outlet for it. Otherwise, it would appear to be a timber which would be useful for heavy constructional work after preservative treatment. Another outlet, where its hardness could be used to advantage, might be as treated paving blocks. It should do admirably for this work.

Sources of supply.—Assam is the only Province possessing this timber and a market is required for it. Good logs of 25 ft. length and about 4 to 5 ft. girth are ayailable in fair quantities.

Prices.—Assam quotes Rs. 30 per ton for logs and Rs. 1-2-0 per c. ft. for sawn squares 24 ft. in length and of 12 inches siding.

Dalbergia species.

Trade name.—Rosewood or Bombay blackwood *(Dalbergia latifolia)* and *sissoo* or *shisham (Dalbergia sissoo).*

Vernacular names.—Dalbergia latifolia is known as *shishum* in Bombay Province, and *Dalbergia sissoo* is known as *shisham* in Northern India.

Dalbergia latifolia.—biti (Coorg), *veetti* (Mal.), *satisal* (Beng.), *sitsal* (Bih.).

Dalbergia sissoo.—tali (Bih.).

Weight.—About 50 to 55 lbs. per c. ft. (air-dry).

Description of the wood.—Normally rosewood is a rich purple-brown to deep purple in colour. The purple colouring is very evident in freshly cut wood, but it tones down to a deep purple-brown or dark-brown with age. *Sissoo* is normally a golden-brown to dark-brown wood without any purple colouration, but it is possible for wood of the two species to be so alike in colour as to defy any differentiation. Rosewood, however, has a distinct characteristic odour, while *sissoo* is odourless. They are two of India's most popular and best known cabinet and furniture woods, and they both deserve their popularity. They are extremely handsome woods, often with rich grain figuring, and if well seasoned, are steady durable cabinet woods of the first quality.

Seasoning.—Both rosewood and *sissoo* can be air-seasoned and kiln-seasoned without difficulty and usually with very little degrade. Green conversion and careful stacking in open piles, preferably under cover, if conditions are severe, will give good results in air-seasoning. Both timbers dry out very readily, and during very hot dry weather, protection against too rapid drying is advisable in order to avoid any tendency of end-cracking. Otherwise both timbers are very docile seasoners, and a few months' open air drying is usually sufficient to season them satisfactorily. Kiln-drying produces equally quick and satisfactory results, and with the drying conditions under complete control it is possible to kiln-season either wood with practically no degrade. Heart-centres are, however, a frequent cause of trouble. They often contain a white calcareous deposit, and it is advisable to box the hearts separately when converting either rosewood or *sissoo.*

Strength.—Both timbers are slightly heavier and a good deal harder than teak. Rosewood is a very hard wood, being on the average 60 per cent. harder than teak. They are both slightly weaker than teak in static bending, but are 40 per cent above

teak in shock resistance and shear. Details of their strength qualities will be found in Appendix I.

Durability.—The heartwood of both timbers is above the average in natural durability. In the "graveyard" tests at Dehra Dun, both woods were in fair condition after 7 years in the ground, a satisfactory performance for such a severe test. Under cover, rosewood and *sissoo* will last for a very long time. The sapwood, however, is very perishable and is quickly attacked by borers and fungi. If sapwood is to be used, therefore, it should be treated. It treats readily enough and with complete penetration of the preservative.

Working qualities.—Rosewood is a hard wood, but, despite this, it is not difficult to saw and work to a beautiful smooth finish. *Sissoo* is equally easy to saw and work, unless excessive interlocked fibre is present, when surfacing to a smooth finish is difficult. Such timber is, however, the exception rather than the rule. Both timbers can be peeled on a rotary lathe after a soaking treatment, but rosewood is inclined to develop numerous small surface cracks in veneer and plywood form. *Sissoo*, on the other hand, is the main stand-by of the Forest Research Institute when good plywood is required quickly, and rotary cutting usually results in the bold grain of sissoo being brought out to the best advantage. In short it is a wood which can be used for the best veneer work or for ordinary commercial plywood. Both timbers are good subjects for steam-bending, *sissoo* being a timber which can be bent even in very large sizes. They both take a very high polish, but rosewood is usually preferred in a waxed finish.

Sissoo was tried at the Institute for laminated air screws, but in this very delicate work, it either developed small cracks or the gluing was unsatisfactory. It makes good marine plywood.

Uses.—Both rosewood and *sissoo* rank amongst the finest of India's cabinet and furniture woods, and this is their proper metier. They are, however, also very good constructional woods and are frequently employed for house-building, floorings and such like purposes. Rosewood is well-known on the European markets as a fine cabinet wood, while *sissoo* being further from the export centres, is not exported. It is used in large quantities by the Ordnance Department in India for gun-carriage wheels, wagon parts and other purposes. The railways appreciate it for floor boards and carriage work, and Northern Indian carpenters look upon it as their standard chair and furniture wood. In Bareilly and other joinery and carpentry centres it is often difficult to find any furniture which is not made of *sissoo*.

Sources of supply.—Bombay is the main source of supply of rosewood, but Madras and Coorg also have a fair outturn.

Smaller supplies can be obtained in the Central Provinces, the United Provinces (from Gonda Division) and Orissa. *Sissoo* is obtainable chiefly from the United Provinces and the Punjab, with limited supplies from Bengal, Assam, Orissa and Sind. Rosewood logs and squares are usually of good length up to 20 ft. or so, with a girth of 4 to 5 ft. *Sissoo* varies in different localities. Plantation supplies are usually straight and of good length, whereas riverain or roadside trees are usually shorter and stouter.

Prices.—Rosewood is quoted by Bombay at Rs. 25 to Rs. 120 per ton in the log. Madras quotes from Rs. 31 to Rs. 650 per ton for the finest selected European quality timber. Other Provinces quote from Rs. 50 to Rs. 100 per ton according to quality (1937). *Sissoo* is priced at Rs. 20 to Rs. 50 per ton in the United Provinces and Rs. 40 to Rs. 45 per ton in the Punjab. Bengal quotes Rs. 45 to Rs. 100 per ton according to quality and other Provinces Rs. 40 to Rs. 60 per ton. All quotations are for logs at forest depots (1937).

Dalbergia sissoides.

Sometimes in South India, a wood remarkably like *Dalbergia sissoo*, even when freshly cut, is met with. It is often passed as *Dalbergia latifolia*, but some Forest Officers refer to it as *Dalbergia sissoides*. It is usually more streaky in appearance than normal rosewood, and is an extremely handsome timber.

Dichopsis species.

(Syn. *Palaquium* species. *Dichopsis elliptica* and *Dichopsis polyantha*).

Trade name.—*Pali.*

Vernacular names.—*Pali*, *tali*, etc.

Weight.—About 40 to 43 lbs. per c. ft. (air-dry).

Description of the wood.—Pale red to reddish-brown woods, usually with a fairly large sapwood of lighter colour. Fairly straight-grained and even-textured and with a slight rubber-like odour when freshly cut, which however appears to pass away when it is dry. Not unlike some of the *poons* in appearance, otherwise they are woods without any conspicuous character.

Seasoning.—In log form, *pali* is apt to develop cracks and end splits in a dry climate, and after conversion these original defects are inclined to increase. Apart from this it is not a difficult wood to season, and sound wood usually air-seasons with little degrade, though a certain amount of warping and spring has been noticed in some seasoning experiments with this species. Green conversion, followed by careful stacking under cover, is recommended (Kapur). Kiln-seasoning offers no difficulties with sound stock.

Strength.—*Pali* and *tali* are very similar to teak in most strength qualities. They are about the same weight and slightly harder and stiffer than teak, but they appear to shrink twice as much as teak in seasoning. Details of their strength qualities will be found in Appendix I.

Durability.—*Pali* is not a very durable wood in outside positions. Five out of six specimens tested in the "graveyard" at Dehra Dun were completely destroyed by rot in 6 years, while the sixth piece, strange to say, was completely sound at the end of the same period. It is unfortunately a very difficult wood to treat and even under severe pressure treatments the end and side penetration is extremely slight.

Working qualities.—Not a difficult timber to saw and work to a fine surface. It is clean and straight in the grain and therefore accepted in workshops as a good average wood. *Pali* from Madras was tried experimentally for rotary-cut veneers and plywood, and was found to peel easily and make up into a grade of plywood suitable for normal commercial purposes. The plywood boards remained flat and free from surface cracks, but under excessive pressure some staining of the wood was noticeable when casein was used for glueing.

Uses.—*Pali* is used in Madras for building purposes, cheap furniture, and shingles, and long straight logs are in demand for masts and spars. It is an average quality commercial constructional wood, but its refractoriness to preservative treatment limits its utility in this direction. It is otherwise suitable for all forms of construction where great durability is not required, or where it is not exposed to fungus attack.

Sources of supply.—Madras is the main source of supply of *pali* while Bengal has good quantities (up to 1,000 tons per annum) of *Dichopsis polyantha* available in the Chittagong Hill Tract. *Pali* is sometimes obtainable in very long straight logs, but fluting is common. The longest logs (up to 40 ft.) come from the Sappal Valley. Supplies good.

Prices.—Madras quotes Rs. 34 to Rs. 37 per ton for *pali* in log form, while Bengal quotes from Rs. 37-8-0 to Rs. 50 per ton for *Dichopsis polyantha* in Chittagong (1937).

Dillenia Species

(*Dillenia indica* and *Dillenia pentagyna.*)

Trade name.—*Dillenia.*

Vernacular names.—*Otenga, chalta, akshi, kalai, rai* (Bih), *kadutega* (Coorg). In Burma *D. indica* = *thabyu* and *D. pentagyna* = *zinbyun.*

Weight.—About 39 to 43 lbs. per c. ft. (air-dry).

Description of the wood.—The *dillenias* are reddish- brown or reddish-grey woods, with occasional white chalky lines showing on the surface. They are rough constructional woods of good strength and hardness. They are rather coarse-textured and sometimes have twisted grain which results in a tendency to warp. *Dillenia pentagyna* is usually a little heavier and darker than *Dillenia indica.*

Seasoning.—These woods have a slight tendency to split at the ends and to warp if twisted grain is present. This latter defect can be much reduced by quarter-sawing. They dry rapidly, and careful stacking in a well protected shed usually results in the timber coming out in good condition. Kiln-seasoning offers no difficulties, and the timber comes out in excellent condition provided it is well sawn and carefully piled.

Strength.—Both timbers are moderately strong. They are slightly lighter than teak and a little weaker in most strength qualities, except shear, in which *Dillenia pentagyna* surpasses teak. Details of the strength qualities of both timbers can be seen in Appendix I.

Durability.—Neither of these *Dillenia* woods is very durable. In the Dehra Dun "graveyard" tests, 6 speciments of each were completely destroyed by white ants and rot within 2 years. For outside use, therefore, it would be advisable to treat these woods. Fortunately, both are easy to treat under pressure, and the absorption and penetration are excellent.

Working qualities.—The *dillenias* are not usually looked upon as difficult woods to saw and work, and when green they are comparatively easy, but after kiln-drying some difficulty in planing has been reported from Burma, due chiefly to the hard chalky or silica deposits so often found in these woods. *Dillenia indica* was tested at Dehra Dun for veneer and plywood work, and although it can be peeled and made up into plywood, it is not considered to be a good subject for this purpose on account of its colour and rather coarse texture.

Uses.—These woods are typical construction woods, which could be used after preservative treatment for practicaliy all purposes where a building timber of good strength is required. When cut on the quarter they have quite an attractive silver-grain, and in Burma advantage has been taken of this characteristic, and the woods are used as inlays against darker timbers. Specially selected quarter-sawn planks might find a market in cabinet and high-class furniture stores.

Sources of supply.—Both timbers are available in medium quantities from Bengal and Assam and smaller lots from Bombay. The largest supplies are available from the Buxa and Chittagong districts in Bengal.

Prices.—Bengal quotes Rs. 18 to Rs. 38 per ton in logs, and Assam quotes Rs. 30 for logs and Re. 1 per c.ft. for squares of about 18 ft. length and 12 inch siding. Bombay estimates Rs. 25 to 40 for logs of *Dillenia pentagyna* (1937).

Diospyros species.

(*Diospyros ebenum, Dispyros embryopteris. Diospyros melanoxylon,* etc.)

Trade name.—Ebony.

Vernacular names.—*Tendu. abnus, Kendu* (Bih.) *karunkali.*

Weight.—About 51 to 56 lbs. per c. ft. (air-dry).

Description of the wood.—The term ebony is loosely applied to many black woods, some of which have no relation to the *Diospyros* family, but the nearly black wood of *Diospyros melanoxylon* is, in India, more commonly traded as ebony. *Diospyros ebenum* is a comparatively rare tree in India, but in Ceylon it is of commercial importance. The heartwood of *Diospyros ebenum* is usually small but true black; that of *Diospyros melanoxylon* is usually a very dark green or greenish-black, while *Diospyros embryopteris* contains a very small dark irregular heartwood which is of little value as a source of ebony. Apart from their ebony heartwoods, the sapwoods of these timbers are of value as commercial woods of great strength, toughnes and shock resisting ability, which makes them useful for tool handle and similar work.

Seasoning.—The dark centre wood of these species is very difficult to season. It has a tendency to split and develop fine surface cracks. It should, therefore, be dried slowly and must be well protected. The lighter coloured portion of the timber dries with comparative ease under normal conditions. There is a liability to borer attack if the timber is left lying about for a long time in log form, but if converted green and stacked immediately for air-drying under cover, the light-coloured timber can be seasoned with little degrade.

Strength.—The ebonies are extremely hard and tough woods. *Diospyros melanoxylon* had a "maximum drop" figure of 50 (as against teak's 27) in the impact testing done on this wood. It is heavier and harder than teak, and is one of the few Indian timbers that can be recommended for tool handle and picker arm work in place of the imported ash and hickory now used. If well seasoned, the outer light coloured wood of all the ebonies should make excellent hammer and tool handles.

Durability.—The black wood of the ebonies is naturally durable, but the lighter coloured portions are not very durable under severe conditions. In the "graveyard" tests at Dehra Dun, 6 specimens (black wood none or 50%) of *Diospyros melanoxylon* were all destroyed by white ants and rot within 4 years. The lighter portions of this wood can be treated satisfactorily with preservatives.

Working qualities.—The ebonies are fairly hard woods, but they are not difficult to saw and work. They can be finished to a fine smooth polished surface. The dark wood is frequently used for turnery and inlay work, and with sharp tools can be turned to extreme smoothness. The light coloured wood can also be worked to a fine surface.

Uses.—The uses of black ebony are well known. In India the most common uses are turnery, carving, walking sticks, umbrella handles and inlay for furniture and fancy articles. It has also been used as a decorative flooring in the form of small blocks. From a commercial point of view, however, the outer light coloured wood is more important in India, and *Diospyros melanoxylon* is used extensively in the localities where it grows for posts, rafters and poles. It has been tried for picker arms and found suitable, and its special qualities of hardness, toughness and smooth finish make it eminently suitable for such work and for all tool handle work.

Sources of supply.—*Diospyros ebenum* is available in small quantities only from Bombay and Orissa. The latter Province can also supply *Diospyros embryopteris* in commercial quantities. *Diospyros melanoxylon* is more common and fair quantities can be obtained from the Central Provinces, Madras, Bombay, Orissa and the United Provinces, and enquiries should be addressed to the nearest Conservator of Forests of these Provinces.

Prices.—The Central Provinces quote Rs. 60 to Rs. 100 per ton in the log. Madras prices are from Rs. 50 to Rs. 60 per ton and Bombay Rs. 21 to Rs. 50 per ton. Orissa estimates Rs. 28 per ton and the United Provinces Rs. 20 to Rs. 25 per ton (1937).

Dyospyros marmorata.

The luxury wood known as marblewood, or zebra-wood, is obtained from the small dark coloured centre portion of *Diospyros marmorata*, which is found only in the Andaman Islands. It is a bizarre bi-coloured wood usually in black and paler coloured stripes. It is available only in small sizes and small quantities and it commands a very high price, Rs. 300 per ton f. o. b. Port Blair being about the average. Enquiries for this wood should be addressed to the Chief Forest Officer, Port Blair, Andaman Islands.

Dipterocarpus species.

(*Dipterocarpus indicus*, *Dipterocarpus turbinatus*, *Dipterocarpus macrocarpus* and others.)

Trade name.—*Gurjan.* Also sold as *jarul* in the Calcutta market.

Vernacular names.—*Gurjan*, *hollong*, *vellayini* (Mal.), *callene* (Can.), etc. Often sold under the name of *jarul*. *Maiyang* and *apetony* are imported gurjans from Siam and the Philippine Islands respectively. Known as penn wood in Karachi.

Weight.—About 42 to 48 lbs. per c. ft. (air-dry).

Description of the wood.—The wood of all the *gurjans* is very similar in colour and general appearance. It is a drab greyish-red in colour, dull and with a somewhat rough feel. It is usually fairly straight-grained and of medium textured. It has no outstanding characteristics and presents a unicoloured surface without much grain or ring marking. When cut on the quarter it shows a fairly conspicuous silver grain effect. It darkens a bit on exposure but still retains its reddish colour.

Seasoning.—All the *gurjans* are moderately easy to air season, in fact it is preferable to air-season these woods rather than to kiln-dry them. Except for a slight liability to borer attack and stain, especially in the sapwood, the *gurjans* usually air-season quickly with very little degrade. Kiln-drying, on the other hand, is not easy. The oil in the wood seems to prevent the free evaporation of moisture. In addition, the shrinkage in kiln-dried *gurjan* is considerable. If quick drying must be done, it would be preferable to partially air-season the wood first and then finish off the drying in a kiln.

Strength.—Taken as a whole, the *gurjans* are good strong woods. They are, on the average, slightly heavier than teak and in most strength functions slightly stronger than teak, but they have a poor shrinkage figure and allowance must be made for this defect. Even after drying they are apt to expand and contract with changes in atmospheric conditions and they should not, therefore, be used where a very close fit is desired. Several of the *gurjans* have been tested at Dehra Dun, and the details of their strength qualities can be seen in Appendix I.

Durability.—The *gurjans* are not very durable woods in exposed positions or in contact with the ground. They are reasonably durable under cover, but it would always be advisable to treat them with a preservative for outdoor use. Under adverse conditions they are readily attacked by rot, and they should not be used untreated in positions where rot is liable to occur. They all treat

fairly readily, and complete penetration and good absorption can be obtained under pressure without difficulty with ordinary air-dried stock.

Working qualities.—All the *gurjans* are comparatively easy to saw and work. They cannot be finished to a very smooth surface as they are moderately coarse woods, but they can be brought to a finish suitable for paint or polish work. Some of the *gurjans* contain an oleo-resin, but this is usually not so evident as to be objectionable. *Dipterocarpus macrocarpus* (*hollong*) has been tried and is used commercially in Assam for making plywood for tea tests, and it is quite suitable for the purpose. Some other *gurjans*, more especially *Dipterocarpus turbinatus* from Burma, do not appear to be very suitable subjects for plywood, but *Dipterocarpus alatus* seems to follow *hollong* in this respect and could be used for making good quality commercial plywood.

In other respects the *gurjans* are useful workshop woods which give little trouble.

Uses.—The *gurjans*, where they occur, are usually available in large quantities, and for this reason they are valuable as commercial timbers. They are good average quality constructional woods, and if treated they would rank high amongst India's building and general purpose timbers. They have been used as treated railway sleepers and done well, in fact *hollong* formed the bulk of the timber treated by the creosoting plant at Margherita in Assam. They are used locally for house-building and general construction, but their excessive shrinkage and liability to expand and contract with changes in atmospheric conditions rather detracts from their usefulness as furniture woods. They have been used with success as flooring woods in Great Britain, but they should be very well dried if they are to be used for this purpose in India. In past years the main export of *Gurjan* to Europe has been to the Great Western Railway. In Europe its poor retention of shape is not such a drawback as in this land, with our great range of humidities and temperatures. It has been used in England as a substitute for European Oak. Its advantage is great size and faultless, clean timber.

Sources of supply.—Large supplies of *gurjan* are available from the Andamans, Bengal and Assam. Burma also can produce large quantities. The South Indian *gurjan* (*Dipterocarpus indicus*) is fairly common on the Southern Ghats and in Coorg and Travancore. In short, *gurjan* is one of the few woods in India which can be produced in very large quantities, amounting to several thousands tons per annum, if the demand requires it, more especially in the East of India. Assam, for example, estimates the outturn of *hollong* at 12,000 tons per annum.

Enquiries should be addressed to the Chief Forest Officer, Andamans or the Forest Utilization Officers, Bengal, Assam or Madras.

Prices.—The Andaman price is at present about Rs. 40 to Rs. 57-8-0 per ton for squares and Rs. 50 to Rs. 80 per ton for machine sawn scantlings (1937). Bengal quotes about Rs. 45 to Rs. 50 per ton for squares from Chittagong, and Assam estimates Rs. 45 per ton for logs up to 30 ft. in length and 6 ft. girth and slightly higher rates for good squares of 24 inch siding (1937).

Duabanga sonneratioides,

Trade name.—Lampati.

Vernacular names.—Lampati, ramdala, khokan (Ass.), etc.

Weight.—About 24 to 30 lbs. per c. ft. (air-dry).

Description of the wood.—A light brownish-grey wood with no distinct heart or sapwood. Very light in weight and coarse-textured. Described by Brown as a timber of the first class and one which shows a very effective silver grain on quartersawn boards. Can be best described as a good quality packing-case wood.

Seasoning.—A non-refractory wood which gives no trouble in either air-seasoning or kiln-drying, provided the logs are converted green and the sawn stock is dried quickly. If left lying about in humid weather there is a strong liability that *lampati* will be attacked by mould stains and fungus, and in log form it is also prone to borer attack. As with other soft woods of a similar type, the important thing is to get the surface of the converted timber dried quickly, and if necessary vertical stacking for a short while before proper seasoning is often benefical in such cases.

Strength.—Lampati is not a very strong wood, but it is also a very light wood. It is not the type of timber to use where any great strength is required. It has, however, been tested at Dehra Dun and the details will be found in Appendix I.

Durability.—It is not a very durable wood, and if required for any permanent use it should be treated with a preservative. In the "graveyard" tests at Dehra Dun, the 6 specimens of untreated *lampati* were all completely destroyed by white ants and rot within 4 years. This is a better record than that of most other similar soft timbers, but it would be far safer to give the wood a preservative treatment if it is required to last. It is a timber which treats with difficulty.

Working qualities.—A very easy timber to saw and work, though it requires a little care to bring it to a smooth surface. It peels exceedingly easily and well on a rotary lathe and makes up into good clean plywood sheets, but is without any distinctive character. It has been used in Assam for plywood tea chest work, but it is below standard in the matter of strength for this purpose. Otherwise, it definitely has possibilities as a plywood timber, but supplies are limited and this would restrict its use for this purpose. In other respects it is a good light-weight timber free of any bad defects.

Uses.—The present uses of *lampati* are planking and box shooks. It is also used for light rafters, battens and wall-

boarding. It has been used for furniture, and it might prove to be a very useful light wood for this purpose as it is steady and clean. It is admirably suited for painted work, and is a very useful type of workshop wood for which there is always a demand in industrial centres.

Sources of Supply.—Supplies in India are restricted to Assam and Bengal, the outturn of the former being greater than that from Bengal. Larger supplies could be obtained from Burma. Enquiries should be addressed to the Conservators of Forests, Assam or Bengal.

Prices.—Assam quotes Rs. 40 per ton for logs of 4 ft. girth and 30 ft. length, while Bengal quotes up to Rs. 30 per ton for similar meterial, and Rs. 75 to Rs. 90 per ton for sawn stock.

Dysoxylum species.

(*D. binectariferum, D. hamiltonii, and D. malabaricum.*)

Trade name.—White cedar.

Vernacular names.—*Bili-devdari, agil* (Coorg), *vellagi* (Mal.).

Weight.—About 45 to 47 lbs. per c. ft. (air-dry).

Description of the wood.—The true white cedar *(D. malabaricum)* is a light-coloured brownish-grey wood, sometimes with a yellowish tint. *D. binectariferum*, on the other hand, has a distinctly reddisn colouring, which ages to a reddish-brown. They both have a cedary smell, and are fine-textured woods of a good class. They are moderately heavy woods of approximately the same hardness as teak.

Seasoning.—The *Dysoxylum* woods do not present any difficulties as regards seasoning. The sapwood is very liable to blue stain, and green conversion and quick stacking in open piles are essential if clean timber is required. Board planks have sometimes been noticed to have spilt down the centre (where there is usually a plane or weakness), and fine hair cracks may appear on board surfaces, but normally these woods can be air-seasoned and kiln-seasoned without any trouble or degrade.

Strength.—The *Dysoxylum* woods are stronger than they appear to be at first sight. They are slightly heavier than teak, on the average, and of approximately the same strength and hardness. In shock resistance and shear they are stronger than teak.

D. malabaricum has been tested at Dehra Dun and its strength qualities can be seen in Appendix I.

Durability.—*Dysoxylum* heartwood appears to have considerable durability and resistance to white ant and fungus attack. In the " graveyard " tests at Dehra Dun, 6 specimens of *D. binectariferum* were all destroyed in 7 years but the 6 specimens of *D. malabaricum* were all attacked moderately to badly at the end of 15 years, none being destroyed. Reports from other sources also show that these two species are naturally durable even under unfavourable conditions.

Working qualities.—White cedar saws and works with ease to a fine finish, and presents no difficulties whatsoever in the workshops. It has been found quite satisfactory for plywood, and has been used for tea-chests. It can be turned to a fine satin-like surface.

Uses.—White cedar is well known as a wood of exceedingly fine quality in the areas where it grows. It is used extensively for

barrel-making (for which it seems to be eminently suited), and also for house construction, furniture, and carriage and wagon work in railway workshops. Being naturally durable, it lends itself to many uses where other timbers fail on account of their perishable nature. In can be described as a general purpose wood of good quality.

Sources of supply.—Unfortunately, supplies of white cedar are hardly sufficient to meet the present domand. *D. malabaricum* is obtainable only on the West Coast, in Madras, Coorg and Mysore. *D. binectariferum* and *D. hamiltonii* can be procured in small quantities only from Assam. Enquiries should be addressed to the Forest Utilization Officers of Madras and Assam.

Prices.—Madras quotes Rs. 75 to Rs. 87 per ton in the log for white cedar. Assam estimates about Rs. 1-6-0 per c. ft. for sawn squares up to 18 ft. in length and of 15 inch siding (1937).

Eugenia species.

(E. jambolana, E. gardneri, E. praecox).

Trade name.—*Jaman.*

Vernacular names.—*Jamun. nir, naval, neralu* (Coorg), etc. Burmese name, *Thabye.*

Weight.—*E. jambolana* 42 lbs., *E. gardneri* 62 lbs., *E. praecox* not known.

Description of the wood.—True *jaman* (*E. jambolana*) is a reddish-grey wood, sometimes with darker markings. It is of medium weight and texture. *E. gardneri* is a much heavier and harder wood of South West India. *E. praecox* is a lesser known wood occurring only in the Chittagong District of Bengal.

They are good woods, and true *jaman* appears to be a timber which deserves more attention than it has received in the past. It is naturally durable, and if well selected makes up into excellent furniture.

Seasoning.—The *jamans*, as a class, are timbers of medium refractoriness from a seasoning point of view. If dried quickly in a hot dry climate, they will develop surface cracks and possibly some end splitting. The aim should, therefore, be to dry them slowly under favourable conditions. Conversion should be done, preferably, in damp or cool weather, and the converted material should be stacked under cover for slow seasoning. True *jaman* is a better seasoner than *E. gardneri*, the latter being very prone to surface-cracking under unfavourable conditions. The timbers can be kiln seasoned without much increase in degrade provided the drying conditions are mild and slow.

Strength.—The *jamans* are strong woods. *E. gardneri* is 40 per cent. heavier than teak and 50 per cent. harder. It is also stronger than teak in most strength functions.

Eugenia jambolana has about the same weight as teak but is 20 per cent. harder. In other respects it has approximately the same strength qualities as teak.

Details of the strength qualities of these two species can be seen in Appendix I.

Durability.—In the "graveyard" tests at Dehra Dun, out of 6 specimens of *E. jambolana* tested, 5 were destroyed in periods varying from 2 to 8 years and one was badly attacked by fungus at the end of 16 years. *E. gardneri*, although a heavier and harder wood did not do so well, the 6 test pieces having been destroyed by rot in about 4 years. This fact has also been recor-

ded in some untreated sleeper tests in Assam, the sleepers failing only from rot after about 7 years. As treated sleepers they did better. Both species can be treated, but *E. gardneri* was found to be rather refractory and did not absorb much preservative. Some green logs of *E. gardneri* sent to Dehra Dun for veneer tests were found, on arrival, to have been attacked badly by rot and borers, so, in a green state, a liability to fungus attack is evidently a defect which needs watching.

Working qualities.—The *jamans* are not difficult to saw and work to a clean finish, but it is recorded that *E. gardneri* was found to be harder to saw when it was fully seasoned. The grain is regularly wavy, and this usually gives a mottled effect on finished boards. If this mottling is bold it gives an extremely handsome appearance to the wood. The logs of *E. gardneri*, sent to Dehra Dun from South India for peeling tests, arrived so badly attacked by rot and borers that no tests could be carried out, but in any case this timber does not appear to be the right types for plywood work. *Eugenia jambolana*, on the other hand, peels well and makes up into good second grade plywood.

Uses.—Both *E. jambolana* and *E. gardneri* are fairly well known as good average woods for construction work and house-building. The former has done fairly well as a treated sleeper on the Bengal and North Western Railway, while the latter has been tried for the same purpose in Madras. Their utility lies more in constructional rather than ornamental spheres, but *E. jambolana* can, at times, produce some very handsome wood which would do well for furniture and cabinet work.

Sources of supply.—*E. jambolana* has a very wide distribution and is found in every Province in India. It is also a tree which is much cultivated and preserved round villages on account of its fruit, and if a demand arose, supplies would probably be forth-coming from almost any corner of India. Bombay, the Central Provinces, Assam, Bengal, Orissa, and the United Provinces can all produce varying quantities, while Madras can supply *E. gardneri* on demand. Enquiries should be addressed to the nearest Conservator of Forests.

Prices.—Bombay and the Central Provinces quote about Rs. 30 to Rs. 50 per ton in the log. Other Provinces quote lower prices ranging from Rs. 20 to Rs. 35 per ton for logs, and Assam estimates Rs. 1-1-0 per c. ft. for sawn timber up to 15 ft. in length and 12 inches siding. Logs of good girth up to 8 ft. are not uncommon (1937).

Gardenia species.

(G. turgida, G. latifolia etc.)

Trade name.—Gardenia. *G. latifolia* is sometimes called Indian boxwood, a bad name in view of the fact that true boxwood (*Buxus sempervirens*) occurs in India.

Vernacular names.—*Papra, dudri, pendra, koinnori* (Beng.), etc. Burmese name, *Yingat* or *hman.*

Weight.—From 47 to 57 lbs. per c. ft. (air-dry).

Description of the wood.—Pale creamy or yellowish woods not unlike boxwood in appearance but slightly coarser. They are very fine-textured woods of the boxwood type, moderately heavy and hard, and without any bold character.

Seasoning.—The gardenias are medium-refractory woods in the matter of seasoning. They have an inclination to develop end cracks and split if dried too quickly, but, if converted timber is stacked under cover and protected from dry winds, it will air season slowly and without excessive degrade. Boxwood suffers from the same liability to end-splitting, and it is customary to saw boxwood logs longitudinally in half soon after felling. This helps considerably to prevent end-splitting, and the same practice might be tried with advantage with *Gardenia* woods, since the logs of these species are small and of the same type as boxwood.

Strength.—Gardenia wood is very hard and tough. It has not been tested at Dehra Dun for strength, as it is not the type of timber in which strength qualities are of importance, being obtainable only in small sizes and used where a very close-textured wood of the boxwood type is required.

Durability.—Gardenia wood is not the type of wood in which durability is an important quality. It is sufficiently durable for all the types of work for which it is likely to be used.

Working qualities.—Being exceptionally close-textured woods, the gardenias are exceptionally fine turnery woods which can be brought to a beautifully smooth natural finish. They are hard but not exceptionally difficult to saw and plane. They are well known as carving woods, and can be classed as probably the best turnery woods in India.

Uses.—True boxwood is very scarce in India, and for this reason such timbers as those of the *Gardenia* species have a special value. There is always a demand for such woods, for making combs, rules, toys and turnery articles generally. The gardenia woods are very suitable for this type of work, although

they do not quite come up to the same standard of quality as true boxwood.

Sources of supply.—The Central Provinces, Bombay, the United Provinces, and Bihar have all intimated their ability to supply gardenia wood in limited quantities. It should, however, be clearly understood that only small logs are available, the average being under 2 ft. in girth and about 8 to 10 ft. in length. Enquiries should be addressed to the nearest Conservator of Forests of the above Provinces.

Prices.—The Central Provinces quote Rs. 50 to Rs. 65 per ton for logs. Bombay quotes about Rs. 40 per ton and Bihar Rs. 25 per ton (1937). The United Provinces rank gardenia as a fuel wood since there is no demand for it for other purposes.

Gmelina arborea.

Trade name.—Gamari.

Vernacular names.—Gumhar, gumbar, gomari, kooli (Coorg), etc. Burmese name, *yemane.*

Weight.—About 30 lbs. per c. ft. (air dry).

Description of the wood.—A light strong wood of first quality. It is usually a pale-yellow or pinkish buff in colour, and is not infrequently marked with roe and mottle figuring. It is a fairly close-textured wood, odourless, and with a smooth feel. It is not very ornamental but is an extremely "steady" wood.

Seasoning.—Gamari is extremely slow to dry both in the open air and in a seasoning kiln. It is not liable to cracking and splitting, but it has a bad tendency to form moisture pockets. (Rehman). Green conversion and open stacking with crossers under cover will give the best results.

Strength.—Gamari is 10 to 12 lbs. per c. ft. lighter, and not so strong as teak. For its weight it is, however, a reasonably strong wood. Details of its strength qualities will be found in Appendix I

Durability.—Gamari has the reputation of being a naturally durable wood. Under cover it certainly has considerable durability, but it does not remain immune to white ant attack for very long if placed in the ground. In the "graveyard" tests at Dehra Dun, 6 test specimens of *gamari* were badly attacked at the end of 7 years. This is not bad, but it is also not very good. Away from incidence of attack by white ants it remains sound for a very long while.

Working qualities.—An easy wood to saw and work to a good finish. It can also be turned to a fair surface, and takes paint or polish extremely well. Usually very uniform in colour and character and without any outstanding features, except for occasional roe-mottling which gives the wood a sheen. Being very "steady" after seasoning, it is regarded by wood workers as a first-class work-shop wood. It peels well on a rotary lathe and makes up into a good second grade plywood.

Uses.—Pearson describes *gamari* as one of the best and most reliable timbers of India. It is certainly very popular wherever it is found and it is a favourite wood of local craftsmen for furniture, panelling, boat-building, boxes, grain-measures and other general utility and domestic purposes. It is a timber which is very suitable for camp furniture, being light, steady and strong, and if supplies were more abundant it would, with little doubt, be

one of the mainstays of cabinet makers and carpentry shops. It a good wood for patterns.

Sources of supply.—Although occuring in most provinces of India, supplies are not abundant. It is more plentiful in Bengal and Assam than in other Provinces, while supplies from the Central Provinces, Bombay, Orissa, and the United Provinces are very limited. Enquiries should be addressed to the nearest Conservator of Forests of the above provinces.

Prices.—Bengal quotes Rs. 30 to Rs. 60 per ton for logs from Buxa, Kurseong and Chittagong Divisions. Assam estimates an average figure of Rs. 45 per ton for logs and Rs. 1-1 per c. ft. for squares up to 15 ft. in length and of 15 inches siding. Orissa quotes Rs. 30 to Rs. 50 per ton, the Central Provinces Rs. 60 to Rs. 90 per ton, and Bombay Rs. 20 to Rs. 60 per ton, according to quality (1937).

Hardwickia binata.

Trade name.—Anjan.

Vernacular names.—Anjan, kamra, yepi (Tel.) *acha* (Tam.).

Weight.—Up to 69 lbs. per c. ft. (air dry). Variable.

Description of the wood.—An extremely hard, heavy and durable wood. The heartwood is usually a dark reddish brown, sometimes streaked with blackish markings. No characteristic odour or taste. Irregularly interlocked grain and of coarse texture. Being nearly twice as hard as teak, aud rather difficult to season, it is not a wood for which there is ever likely to be much demand, except for local purposes when better timbers are not procurable.

Seasoning.—A refractory wood to season. It develops surface cracks when drying and is liable to warp if not well piled. This wood should be converted as green as possible. and the converted material should be properly stacked with sufficient protection to prevent too rapid drying. If care is taken, *anjan* can be seasoned without undue degrade, but it is a wood which needs careful handling and slow drying. It has been noticed that the wood is liable to be attacked by borers both in log form and during seasoning.

Strength.—Anjan is an extremely hard, heavy and fairly strong wood. It is nearly twice as hard as teak, but in actual strength as a beam or in stiffness, it does not come up to the strength of teak.

Durability.—A naturally durable wood against rot and white ants, but during various air-seasoning experiments it was found to be attacked by borers. On the whole, however, *anjan* can be taken as a wood which is well above the average for durability. The heartwood is refractory to treatment with wood preservatives. If treatment is required, a full cell treatment should be given, as the absorption and peneration is not likely to be very good.

Working qualities.—Being extremely hard, especially when seasoned, it is an exceptionally difficult wood to saw and work, It should be converted green, as most sawyers refuse to touch it when dry. It can be worked to a fair finish, but much labour is required to accomplish this. It has never been tested for rotary veneer work, but it appears to be too hard for this purpose.

Uses.—Anjan is used fairly extensively locally when a very heavy hard wood is required, such as for naves of cart wheels, ploughs, clod crushers and machine bearings. It is also used for posts and beams and for mine props. It should do well for wood

block paving, railway keys, tent pegs, brake blocks and godown floorings. It is a substitute for *lignum vitæ* for bearings.

Source of supply.—Available in Madras, Bombay, Mysore and the Central Provinces. It is usually found as a scattered tree, but in some forest divisions it occurs in gregarious patches. Supplies could always be arranged by applying to the nearest Conservator of Forests of the above Provinces. Logs up to 4 ft. girth are available, but 3 ft. girth is the more usual maximum.

Prices.—The Central Provinces quote Rs. 50 to Rs. 70 per ton for logs up to 3 ft. girth. Madras quotations range from Rs. 25 to Rs. 90 per ton for logs according to quality, while Bombay estimates Rs. 20 to Rs. 45 per ton (1937).

Hardwickia pinnata.

Trade name.—Piney.

Vernacular name—Shurali (Mal.), *compaini* (Coorg), *kolavu, uram.* Has been called satinee and Malabar mahogany, but both names are unsuitable and should be discouraged.

Weight.—About 43 to 45 lbs. per c. ft. (air dry).

Description of the wood.—The sapwood is usually large and of a dirty whitish colour. The heartwood is a dark brownish red and the wood often exudes a sticky resin. Medium-coarse-textured with broadly interlocked grain. Mottling and fiddleback figuring is sometimes found, and wood with such figuring is extremely handsome. This species is classed by Brown as a timber of the first class.

Seasoning.—The sapwood is extremely liable to decay, discolouration, and insect attack, and should be discarded unless required for preservative treatment. The heartwood seasons well with little cracking or splitting, except along original cracks and shakes in the centre of the logs. Some $2\frac{1}{2}$ inch planks were air seasoned down to 8 per cent. moisture content in 1 year at Dehra Dun without degrade.

If this timber is carefully stacked under cover and air-seasoned under favourable conditions, it should come out in very good condition. Radial sawn planks are liable to develop spring. (Kapur). It has been kiln-seasoned as 1" boards in 18 days without any appreciable degrade at Dehra Dun. (Rehman).

Strength.—Piney is a fairly strong and moderately hard timber. Strength figures for this wood will be found in Appendix I. It is about 80 to 90 per cent. as strong as teak.

Durability.—The sapwood is very perishable and liable to discolouration and insect attack.

The heartwood is naturally fairly durable. In the Dehra Dun "graveyard" tests, 6 specimens lasted for over 6 years before they were destroyed. The resin in the wood probably helps to protect it against adverse agencies. It is not a wood which has been tested for preservative treatment.

Working qualities.—Piney is not a difficult wood to saw and work to a good finish. It can be brought to an excellent lustrous surface with very little labour. It will also take a polish, but the natural resin is inclined to effect the finish as time goes on. It is a good turnery wood, and might be suitable for rotary veneer work, but it has not been tested for such work.

Uses.—A fairly well known wood in South India. It has also been exported to Europe but no great trade in it has been developed. It is used primarily on the West Coast for building purposes, and is commonly seen as beams, rafters, battens, ceiling boards and flooring. It is also used for furniture, and, as mentioned above, selected stock can be very handsome with beautiful fiddle-back mottling. With careful selection it might prove to be a very useful cabinet wood. It might quite conceivably produce some very handsome veneers both by the peeling and slicing methods.

Sources of supply,—A South West Coast wood, common in Coorg and Travancore, and moderately so in the ghat forests of Madras. Logs up to 6 ft. girth are available. Supplies can be obtained by application to the Forest Utilization Officer, Chepauk, Madras, or the Chief Forest Officer, Coorg.

Prices.—Madras quotes Rs. 37 per ton as the average price for logs of this species. Coorg estimates an annual outturn of 18,700 c. ft. in log form, and quotes Rs. 7 per candy of $12\frac{1}{2}$ c. ft. at Baliapatam (1937).

Heritiera fomes.

(Syn, *H. minor*).

Trade name.—*Sundri.*

Vernacular name.—*Sundri.* Burmese name. *Pinle-kanazo.*

Weight.—58 to 65 lbs. per c. ft. (air dry).

Description of the wood.—Sapwood pinkish-grey or buff. Heartwood dark reddish-brown. A dull wood without any characteristic odour or taste. Very heavy, hard and tough, with somewhat interlocked grain, but of fine texture. No characteristic odour or taste. Can be described as a dull but sound utility wood. The wood from trees that have died naturally is said to be much superior to the wood of live trees. A rather similar wood, common in the Andamans and also a coastal forest tree, is *Bruguiera gymnorhiza*. It grows to greater lengths than *sundri* and as it takes preservative treatment well, it might be useful for pole work. It still remains to be seen, however, whether it can be seasoned satisfactorily in pole form, as the wood has a tendency to split from the ends.

Seasoning.—A wood that is prone to surface cracking, but otherwise not difficult to season. It dries out slowly, and, as regards seasoning qualities, is not unlike *sal*. Some scantlings kiln-dried at Dehra Dun came out in good condition, but showed that low temperatures and slow seasoning are necessary if surface cracks are to be avoided. It should be converted green and dried slowly under cover but with a good air circulation.

Strength.—*Sundri* is a very hard, tough, strong wood. It is nearly twice as hard as teak and 10 to 20 per cent, stronger. At the same time, it must be remembered that it is also 50 per cent, heavier. An excellent wood where strength, toughness, elasticity, and hardness are required.

Durability.—A naturally durable wood, well above the average in this respect. Pearson quotes boats built of *sundri* having lasted 60 years or more, while records of untreated posts showed a life of 18 years in a damp locality. At Dehra Dun it lasted 56 months in the "graveyard" tests under severe conditions. The sapwood treats readily with preservatives, but the heartwood is more refractory and usually comes out mottled or treated in patches. A full-cell treatment should be used for this wood. *Bruguiera gymnorhiza*, mentioned above, only lasts twelve to eighteen months as an untreated pole.

Working qualities.—Although a hard wood, Indian *sundri* is not very difficult to saw or work to a good finish. It is one of the commonest woods used in Calcutta for country boat building, and

this is fairly good evidence that it is not a very difficult wood to deal with, although in Burma it has been found very hard and difficult to saw once it has dried out. It has not been tried for veneers, for which it is probably too hard and heavy, but it turns to a good finish and takes a nice polish.

Uses.—Sundri is a well known wood in Calcutta, where it is brought in large quantities from the Sunderbans. Its greatest use is for fuel, but it is also extensively employed for boat building and other purposes. It has been in use for centuries as a boat building and carriage and cart timber, and for constructional purposes. It has been tried for tool handles and picker arms, and reports indicate that, if properly seasoned, it is suitable for the larger types of helves but that it is on the heavy side for hammer and tool handles and picker arms. It is actually in use in railway and other workshops as a tool handle wood and is often accepted for this purpose but careful seasoning to avoid small hair cracks developing (which chafe the hands) seems to be a necessary adjunct to its utilization for tool handles. Very suitable for pulley-blocks, tent pegs, pitprops and similar work where its hardness and strength are used to advantage.

Sources of supply.—The main source of supply of *sundri* is from the Sunderbans forests of Bengal, whence it is brought by country boats or rail to Calcutta. Most Calcutta timber merchants carry stocks of this wood, which is in constant demand for fuel, boat-building, constructional purposes, and other domestic demands. Large logs are not available, in fact most of the *sundri* coming to Calcutta is in small sizes and pole form.

Prices.—Bengal quotes Rs. 25 to Rs. 30 per ton in log form (1937).

Holoptelea integrifolia.

Trade name.—Kanju. Has been called Indian elm, an unsuitable name, as there are true elms *(Ulmus* species) in India.

Vernacular names.—Papri, kanju, chilbil (Bih.). Burmese name, *Myaukseik.*

Weight.—39 to 41 lbs. per c. ft. (air-dry).

Description of the wood.—A uniform cream-coloured wood, darkening a little after exposure. Frequently has a greyish tinge which is due to fungus discolouration. Slightly interlocked grain in broad bands but of even and medium texture. Has a fairly distinct odour when freshly cut, but this disappears as the timber dries. A good light coloured wood of medium weight but without much strength. As regards texture, it can be placed half-way between a very open pored wood like *semul* and a very even textured timber like *haldu.*

Seasoning.—Kanju is very prone to discolouration by sapstain fungi. It is also liable to insect attack before it is thoroughly seasoned. It can, however, be air-seasoned quickly without undue degrade, although a certain amount of warping and surface cracking may result if the timber is not carefully piled. One inch boards air-seasoned at Dehra Dun dried down to 5 per cent. moisture content in a month with practically no degrade. It is a wood which should be dried as soon as possible after conversion to prevent fungus and insect attack. It can be kiln-seasoned without degrade, retaining its initial brightness to a remarkable degree.

Strength.—Kanju is not a wood which is usually employed where great strength is required. It has about 65 per cent. the strength of teak in bending and stiffness, but is equal to teak in shock resistance. It is 85 per cent as heavy as teak and 80 per cent. as hard. Taken as a whole its strength is about average for its weight.

Durability.—Not a durable wood, especially in a green or semidried condition. Once it is dry, however, it is reasonably durable in sheltered and well ventilated locations. It is, however, not a timber to use where great durability under adverse conditions is required. It takes preservatives fairly readily, but should be given a pressure treatment if required for outside use.

Working qualities.—An easy wood to saw and machine, but on account of its bands of interlocked fibre it cannot be brought to the same finish as is possible with *haldu.* It takes a good polish after proper filling has been done, and, generally speaking, can be described as a good average wood in so far as its working

qualities are concerned. It can be turned to a fair surface but has not been tested for veneering.

Uses.—Kanju is a common and well known timber in the United Provinces, Bihar, Orissa and on the West Coast. It is used for a variety of purposes such as cheap grades of furniture, box shooks, match boarding, cotton reels, slate frames, carving, brush backs and handles, and for numerous other domestic purposes. If was tried for bobbins at Bareilly but was finally discarded in favour of *haldu*. It has been used for match manufacture but is not very popular for the purpose on account of its staining propensities. It is most suited for box making and it is largely used for the purpose where it is plentiful. If seasoned quickly it makes an excellent box wood.

Sources of supply.—Large amounts are available from the United Provinces, the Western Circle alone being capable of producing 90,000 c. ft. in the log. Also available in more limited quantities from Bihar, Orissa, and parts of the Central Provinces. Occurs also in the West Coast ghat forests of North Malabar.

Prices.—The United Provinces quote up to Rs. 25 per ton for logs 5 feet or over in girth and of 15 ft. length. Bihar quotes Rs. 30 to Rs. 35 per ton for logs of similar dimensions (1937).

Hopea species.

(*H. odorata* and *H. parviflora*).

Trade name.—Hopea. Called *thingan* in Burma.

Vernacular names.—Thingan (And.), *irubogam* (Tam.), *kongu, hegge* (Can.), *irupu* (Coorg), *telsur* (Beng.), etc.

Weight.—H. odorata, about 47 lbs. per c. ft.; *H. parviflora*, about 58 to 62 lbs. per c. ft. (air-dry).

Description of the wood.—The *hopeas* are dull greyish-brown or reddish brown woods, sometimes showing a yellowish tinge. No distinct odour or taste. Moderately heavy to heavy with a fairly fine even texture. Bands of interlocked fibre are prominent in both species. They are strong, tough, durable, and very hard utility woods with no great outstanding features of colour, texture, or grain. *H. odorata* is a Burma species occurring also in Bengal, Bombay and the Andamans. *H. parviflora* is found only in South India. Other species such as *H. glabra* and *H. wightiana* are not uncommon in South West India.

Seasoning.—The *hopeas* can be classed as moderately refractory woods for seasoning purposes. If well piled under cover with a good air circulation, these woods dry out without any serious deterioration. Sometimes a certain amount of surface cracking and splitting down the pith line is experienced, but on the whole very good results can usually be obtained with a little care and attention. Green conversion and careful stacking under cover is the method recommended for these woods. They are both rather slow seasoners. They can be kiln-seasoned without difficulty or degrade.

Strength.—H. parviflora is a very strong tough and elastic wood. It is 20 per cent. stronger than teak in all strength functions and twice as hard. *H. odorata* is approximately the same weight and strength as teak and is 30 per cent harder. *H. glabra*, a South Indian species, is another wood which is very hard and strong. It is 125 per cent. harder than teak and about 30 per cent. stronger.

Durability.—The *hopeas* are all naturally durable woods, and are well above the average in this respect.

H. parviflora has been described as able to "stand any exposure out of doors in the worst climate". *H. odorata* lasts 15 years or more as an untreated sleeper, and dugouts made of it are said to last 60 years or more. Both woods are very refractory to preservative treatment in so far as the heartwood is concerned. The sapwood treats readily.

Working qualities.—Both woods are very hard and are consequently somewhat difficult to saw and work. They can, however, be brought to a good finish and they take polish readily.

Uses.—The *hopeas* are typical strong durable constructional woods. They are much prized for boat-building and are used for bridge work, piling, beams, rafters, masts, cart-building, railway sleepers, and many other purposes where their special qualities of great strength, hardness, and durability are required. They are also used for furniture, and *thingan* is reputed to be the best general purpose wood, next to teak, in Burma. *Thingan* has been tried as a substitute for persimon.

Sources of supply.—H. odorata is obtainable chiefly from Burma, but fair quantities are also procurable from Bengal and lesser quantities from the Andamans and Bombay.

H. parviflora is a South Indian wood and is obtainable from most West Coast ports or timber depots. Both species are available in good lengths and good sizes up to 6 ft. girth. Enquiries for *thingan* should be addressed ro the Chief Forest Officer, Andamans, and for other species to the Forest Utilization Officer, Chepauk, Madras, or the Chief Forest Officer, Coorg.

Prices.—Bengal quotes Rs. 30 to Rs. 40 per ton in the log for *H. odorata* from Chittagong. Bombay quotes Rs. 50 to Rs. 70 per ton for the same species (1937). Madras quotes Rs. 44 to Rs. 62 per ton in the log for *H. parviflora*, and Coorg Rs. 13 per candy of $12\frac{1}{2}$ c. ft. at Baliapatam.

Hymenodictyon excelsum.

Trade name.—Kuthan.

Vernacular names.—Baurang, bhorsal, bhaulan, doddi (Coorg), *bhurkhund* (Bih.), *latikarum* (Beng). Burmese name: *Kuthan.*

Weight.—32 lbs. per c. ft. (air-dry).

Description of the wood.—The colour of the wood is white when first exposed. This tones down to a light buff on exposure. The sapwood and heartwood are indistinguishable. No characteristic odour or taste. Usually straight-grained and of medium texture. A useful light non-ornamental wood of good quality.

Seasoning.—A very easy and satisfactory wood to air-season. Except for a possibility of slight fungus discolouration, *kuthan* usually dries out with very little deterioration, and is usually free of splits and other defects. It can also be kiln-seasoned without trouble or degrade. Green conversion followed by careful stacking in a well ventilated shed, is recommended as the best method of seasoning this wood.

Strength.—Kuthan is not a strong wood. It has only about half the strength of teak, and is only about half as hard. It keeps its shape well. It is not a timber to use where great strength is required, nor is it the type of timber usually used for such a purpose.

Durability.—Kuthan is a timber of only moderate durability. In the "graveyard" tests at Dehra Dun, all specimens were destroyed in under 3 years. It can be treated fairly readily with preservatives.

Working qualities.—A very easy wood to saw and work. It turns well, and can be brought to a fine finish with very little trouble. In polishing it has been found to absorb rather a lot of polish. Possibly with proper filling this defect conld be remedied. It takes stains very uniformly. It has been tested at Dehra Dun for rotary cut veneers and came through the tests extremely well. It is one of the few white Indian species so far tested which has given veneers and plywood of a really good quality.

Uses.—In the past, this wood has not been exploited to any very large extent. Of recent years, however, it has come more and more into favour, and it is obviously a wood which should be cultivated. Whenever it has been tried for any purpose, it has been reported on as good. It is much favoured in brush factories and has been suggested as a possible substitute for beech, but appears to be a little on the soft side for some purposes for which

beech is used. It has been accepted as a match wood, and is also popular for toys, scabbards, grain measures, drums, slack cooperage and other purposes. Eminently suitable for box planking and plywood, and is just the sort of wood of which India could use large quantities, but of which there are limited supplies.

Sources of supply.—Assam, Bengal, Bihar, Orissa, and the United Provinces all report supplies available, but in no case are there concentrated supplies of any great quantity. Enquiries should be addressed to the nearest Conservator of Forests of the above Provinces. A species of which concentrated supplies should be provided for the future. In favourable localities, it attains a large size, but logs above 5 ft. girth are not commonly marketted. Available also in fair quantities in Burma.

Prices.—Assam quotes about Rs. 35 per ton in log form, and Rs. 1-2 per c. ft. for squares up to 18 ft. length and 15 inch siding. Bengal has smaller quantities at about Rs. 18 to Rs. 25 per ton in Kurseong, Buxa and Chittagong Divisions. Bihar and Orissa have fair supplies at about Rs. 30 to Rs. 38 per ton. The United Provinces can supply at about Rs. 25 per ton in the log. (1937).

Juglans regia

(J. règia and *J. fallax).*

Trade name.—Walnut.

Vernacular names.—*Akhrot*, *akhor*, *khor*, etc. Burmese name. *Thitcha.*

Weight.—About 36 lbs. per c. ft. (air-dry), but specimens weighing between 28 and 43 lbs. per c. ft. have been recorded.

Description of the wood.—The well known greyish-brown wood of walnut, often beautifully mottled and figured, requires little description. Indian walnut varies considerably in colour, some times being a dull grey, while other wood may be a dark brown with even darker markings. It is not, however, the colour alone which has given walnut wood its great reputation. It is a relatively light wood for its strength, and it works very easily and finishes to a fine surface. Its most important quality, however, is that, when once dried, it does not shrink, swell, or split excessively even when exposed to adverse climatic conditions. This, combined with its lightness, strength, and good working qualities gives it pre-eminence as a wood for rifle parts, gun stocks, high class cabinet-making, and delicate carvings.

Seasoning.—Walnut wood seasons slowly and shrinks considerably while drying out, but apart from this, it is a model wood in so far as seasoning is concerned, both in air-drying and kiln-drying. Green conversion, followed by stacking under cover with a good air circulation. is the method of seasoning recommended. Under normal conditions walnut wood, dried with reasonable care, comes out free of defects, except possibly for end splits in large planks. End-painting of the planks helps to reduce this danger.

Strength.—For its weight, walnut is a relatively strong wood. It is about 85 per cent. the weight of teak and in shock resistance is about equal to teak.

Durability.—Walnut is not a very durable wood and it does not offer much resistance to white ant and fungus attack. In the Dehra Dun "graveyard" tests, it lasted only for about 2 years under adverse conditions out of doors. If required, a colourless preservative could be applied by brushing, if protection is wanted when furniture is being made.

Working qualities.—An extremely easy and pleasant wood to saw and work to a fine finish. It will stand up well to high speed machining and turning, and will finish to a clean edge. Used extensively in Kashmir and North India for carving, for which it is eminently suitable. Well known as an excellent

veneer and plywood timber. Takes an excellent polish and needs very little filling.

Uses.—The greater portion of the walnut from Kashmir, where the chief supplies come from, is used by the Indian Ordnance Department for army rifle parts. Large quantities are also used for furniture making and carving in Kashmir and North India. It is also used for gun stocks, and numerous other purposes. Where a really steady, easily worked wood is required, there are few timbers which can rival walnut, and if good figuring is present, there is no wood more handsome.

Sources of supply.—The main supplies of walnut in India come from Kashmir, and enquiries for this wood should be addressed to the Conservator of Forests, Utilization Circle, Baramulla, Kashmir. Smaller quantities can be obtained from the hill divisions of the Punjab, the North-West Frontier Province, and the United Provinces. Enquiries should be addressed to the Chief Conservator of Forests, Lahore, or to the Utilization Officer, Naini Tal, U. P.

Prices.—Prices vary considerably according to quality, Kashmir quotes Rs. 4 per c. ft. for first class planks $10' \times 12'' \times 3''$, and Rs. 3 per c. ft. for 2nd class planks of a similar size. One of the chief walnut markets is in Amritsar and supplies can usually be obtained from dealers there. Burr wood is also sometimes obtainable through these dealers.

Walnut burr wood.

Enquiries are often made as to whether walnut burrs are obtainable in India. Such burrs are available in very limited quantities from Kashmir, but owing to the heavy exploitation of these burrs some years ago, the present supply is not extensive, and most of the large burrs have already been extracted.

Anyone wishing to purchase Kashmir walnut burrs should get in touch with the forest contractors and timber mechants concerned, through the Chief Conservator of Forests, Srinagar, Kashmir.

In April 1940, a London firm stated the best thickness for walnut burr veneers was 1/32nd of an inch. The price was 3 to 8 pence per sq. feet.

In 1942 walnut burrs were quoted in Rawalpindi at Rs. 162 per maund.

Lagerstrœmia flos-reginæ.
(and L. hypoleuca)

Trade name.—Jarul. Pyinma is also used.

Vernacular names.—Pyinma (Burma and Andamans), *ajhar* (Ass.), *nirmarud* (Coorg).

Burmese names :—*Lagerstrœmia flosreginœ. Pyinma* or *pyinma-ywetthe. L. macrocarpa. Pyinma* or *pyinma-ywetgyi.*

Weight —37 to 40 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood greyish white, fairly wide. Heartwood pale red, dulling to brownish red on exposure. No characteristic odour or taste. Usually straight-grained and of medium texture. A good quality, hard, durable, strong wood, which is much in demand, on account of its ease of working, steadiness in use, and durability. A valuable wood for many purposes.

Seasoning.—An easy wood to season if carefully stacked and dried slowly. Some seasoning experiments have yielded 100 per cent of sound stock. Trees girdled 2 years previously appear to give the best results in so far as seasoning is concerned, but green timber converted promptly after felling and stacked carefully under cover with protection against too rapid drying, usually seasons with excellent results. It is a slow drying wood and seasoning should not be accelerated. At least six months should be allowed for one-inch stock to dry out. It kiln seasons easily without degrade.

Strength.—Jarul is about the same weight as teak and slightly harder. In strength functions it is slightly below teak, but it is nevertheless a strong wood suitable for almost all purposes for which teak is used.

Durability.—Jarul is naturally a fairly durable wood. At the same time, it is attacked by white ants as time goes on. In the Dehra Dun "graveyard" tests, the specimens were destroyed in periods varying from 3-13 years, the average being about 6 years. Such deterioration as there was, was due to white ants, and the specimens were free of fungus attack. It is a difficult wood to treat, and even the most drastic treatment does not result in an absorption of more than about 2 lbs. per c. ft. in the heartwood.

Working qualities.—An easy wood to saw and work. It can be finished to a fine smooth surface and sharp edge without difficulty. It was tested for rotary cut veneers but proved unsuitable, being too coarse and loose fibred. It takes a good polish, and can be turned to a smooth surface.

Uses.—*Jarul* is already well known as a fine constructional wood, and is in demand for railway wagon work, floor boards, house-building, boat building and many other purposes. It was pronounced very suitable for boot lasts, and should do for shoe heels, mill work, interior fitments, and similar purposes. It is one of the best medium weight constructional woods which India possesses.

Sources of Supply.—Supplies are available from Bengal and Assam, but the demand already exceeds the supply in most places. Bombay and Madras can also supply limited quantities from the West Coast forests. Burma has fairly good supplies. Enquiries should be addressed to the nearest Conservator of Forests of the Provinces mentioned above.

Prices.—Assam quotes Rs. 60 per ton up to 5 ft. girth and Rs. 1-12 per c. ft. for squares 18 ft. long by 12 inch siding. Bengal quotes Rs. 40 to Rs. 60 per ton in log from Chittagong, Bombay estimates Rs. 50 to Rs. 70 per ton in log form (1937)

Lagerstrœmia hypoleuca.

Lagerstrœmia hypoleuca (Andaman *pyinma*) is very similar to *jarul* in appearance, but is slightly heavier and stronger. Its weight is 42 to 53 lbs. per c. ft. It is easy to work and season, and is more durable than *jarul*. Available is large sizes from the Andamans at about Rs. 60 per ton sawn (1937). It is frequently sold in the Calcutta market as *jarul* and it is now officially recognised under the trade name of *jarul*. Unfortunately *gurjan* is very often passed off as *jarul* in the Calcutta market. The timber is excellent for piles, being very resistant to marine borers. It did very well as planking for a motor launch.

Lagerstrœmia lanceolata.

Trade name.—*Benteak.*

Vernacular names.—*Nana* (Bomb.), *nandi* (Coorg), *venteak* (Tam).

Weight.—About 45 or 46 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood greyish-white. Heartwood light reddish brown, toning to a darker shade on exposure. No odour or taste. Usually straight-grained and rather coarse-textured. A useful utility wood if properly seasoned.

Seasoning.—A refractory wood to season, and one very liable to end-splitting and warping if not carefully handled. If properly stacked under cover, however, and if well protected from too rapid drying, it can be seasoned with very little degrade. In kiln-seasoning it gives no difficulty, which shows that it is a wood which, if handled carefully and dried slowly, can be air-seasoned without degrade. It is a popular wood on the West Coast for boat-building, which is again evidence that in a mild climate it dries out and remains steady without much trouble. This has been proved by other practical trials elsewhere.

Strength.—*Benteak* is a wood which approaches teak very closely in strength functions. It is about the same weight and about the same strength in bending, stiffness and shock resistance. In hardness, it is about 20 per cent above teak. Taken as a whole, it is a good strong wood suitable for all constructional purposes, and especially where elasticity and spring are required.

Durability.—A moderately durable wood which is not prone to fungus attack. In the "graveyard" tests at Dehra Dun 4 out of the 12 specimens tested were destroyed in periods ranging from $3\frac{1}{2}$ to 11 years and the balance moderately to badly attacked at the end of 12 years. A difficult wood to treat with preservatives. Experiments done at Dehra Dun showed that an absorption of more than 2 to 3 lbs. per c. ft. cannot be expected in the heartwood.

Working qualities.—This wood presents no difficulties in sawing and working, either on machines or by hand. It finishes to a fine smooth surface and takes a good polish. It usually has a fine straight grain. It was tried for rotary cut veneers at Dehra Dun but did not appear to be very suitable for the purpose.

Uses.—*Benteak* is a very popular wood at some West Coast ports for boat-building, and it is one of the timbers which the Arabs buy in large quantities for building their dhows and for

exporting to Iraq. It is also largely used for house-building, furniture, carriage-building and general carpentry. Accepted by the Railways for wagon floor boards and other parts of trucks and wagons. Tried and found good for picker arms. An excellent all-round constructional wood well above the average. In Madras it is a favourite wood for bus bodies and large quantities are used for this purpose.

Sources of supply.—Available from Madras, Bombay and Coorg in good logs from 12 to 20 ft. in length and up to 7 ft. in girth. Enquiries should be addressed to the Chief Conservator of Forests, Bombay, the Forest Utilization Officer, Madras, or the Chief Forest Officer, Coorg.

Prices.—Madras quotes Rs. 19 to Rs. 56 per ton in log form, according to size and quality. Bombay quotations range from Rs. 32 to Rs. 80 per ton for logs from Dandeli, Hubli, Kodibag, and other depots. Coorg quotes 4 to 6 annas per c. ft. at forest depots (1937).

Lagerstrœmia parviflora.

Trade name.—Lendi

Vernacular names.—Nandi, sidak, dauri, lendia (C. P.), *chennangi* (Coorg), *sidha* (Bihar). Burmese name: *zaungbale* or *kyet-taw-sa.*

Weight.—About 46 or 48 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood greyish white. Heartwood brownish grey or sometimes a greyish brown. No taste or odour. Usually straight-grained but sometimes with twisted fibres. Rather coarse in texture. A moderatelv heavy hard wood, very difficult to season, but naturally durable for some years even under adverse conditions. If it was an easier wood to season it would be an extremely useful general utility wood.

Seasoning.—Lendia is not an easy wood to air season without degrade. It is prone to end splitting, surface-cracking, and warping. To obtain the best results it should be converted green, preferably in damp or cool weather, and carefully piled under cover, well protected from hot winds and sun, and allowed to dry out slowly. Kiln seasoning presents no great difficulties, and wherever possible kiln drying should be adopted if this is possible. In air seasoning, at least 2 years should be allowed for drying 2 inch stock of this wood. End-coating scantlings or planks will help to minimize end-splitting.

Strength.—Lendi is slightly heavier and harder than teak, and approximates teak in most strength functions. In shear and shock resistance it is well above teak. If well seasoned it can be used for all ordinary purposes for which teak is used, and can be described as a useful strong general utility wood.

Durability.—A wood of fair natural durability. In the Dehra Dun "graveyard" tests it lasted for about 4 years under very adverse conditions. It can be treated with preservatives, but penetration in the heartwood is poor. The absorption in some sleeper treating experiments with this wood varied between 2 and 10 lbs. per c. ft. and the penetration was patchy.

Working qualities.—A fairly easy wood to saw and work. Saws with less trouble when green. Logs with twisted fibre are inclined to run crooked off the saw, but straight-grained wood presents no great difficulties. It can be finished without much work to a fine surface, and takes a good polish after careful filling. Has not been tried for veneers and is probably unsuited for the purpose.

Uses.—Lendi would be a far more sought-after and useful wood if it could be air-seasoned more easily. It is, however, fairly

well known in the localities where it occurs and is used extensively for building in the form of posts, beams and rafters. It is also employed for constructional work, bridges, cart-building, boards and cooperage. It was passed by the East Indian Railway for tool handles and has been used successfully for bent-wood work. Once it has been seasoned it is a good general utility wood of more than average merit, and if kiln-seasoned can be used for almost any purpose. It is a good fuel wood.

Sources of supply.—Found all over India in moist plains' forests. Bengal have large stocks and wish to find an outlet for it. Assam, the United Provinces, the Central Provinces, Bihar, Orissa, Bombay and Coorg can all supply varying amounts.

Enquiries should be addressed to the nearest Conservator of Forests of the above Provinces or the Chief Forest Officer, Coorg.

Prices.—Lendi is usually a fairly cheap wood. Prices quoted vary from Rs. 16 to Rs. 50 per ton, the average being about Rs. 20 per ton, the price quoted by Bengal, Bihar, Orissa, and the United Provinces (1937).

Lannea grandis.

(*Odina wodier*)

Trade name.—Jhingan.

Vernacular names.—Mohin (C. P. and Berar), *godda* (Coorg). *doka* (Bihar), *Modal.* Burmese name: *nabe.*

Weight.—Average about 35 or 36 lbs. per c. ft (air-dry), but considerable variations in the weight of this wood have been recorded.

Description of the wood.—Sapwood whitish and wide. Heartwood pinkish-red toning to a darker shade of brownish red with age. No taste or odour. Usually straight-grained, but often with interlocked bands of fibre. Fairly even texture. A good quality wood, which, if it could be seasoned quicker, would probably be in greater demand than it is at present.

Seasoning.—A slow and difficult wood to season. The sapwood, which forms the bulk of the stem, is extremely liable to decay and insect attack, while the heartwood dries out more slowly than any wood yet tested at Dehra Dun. Some 1½ inch boards dried at the Forest Research Institute, required 3 years to attain a moisture content of about 11 per cent. At the end of this period the sapwood was badly fungus and insect attacked and the heartwood was not evenly dried. The best procedure for dealing with this wood, would be to treat the sapwood and heartwood separately. The former could be dried out quickly in a free circulation of air, while the latter could be stacked for slow drying in a well protected place. Owing to the gum in *jhingan* wood it is almost impossible to kiln season this timber. The gum seems to form an impermeable layer on the outer surfaces of the wood under the action of heat and this prevents the exudation of moisture from the interior.

Strength.—The *jhingan* officially tested under Project I at Dehra Dun did not prove to be very strong. It was comparatively light in weight, and had only about 50 per cent the strength of teak in bending and compression. In shock resistance and shear it was better, while in hardness it was about 30 per cent below teak. Owing to the extreme variations recorded at different times for the weight of this wood, it is possible that the consignment tested was below average. The writer has often seen other samples of *jhingan* which were distinctly on the heavy side and appeared to be the equal of teak in all strength functions.

Durability.—The sapwood is not durable, and perishes quickly from fungus and insect attack, especially if in an unseasoned state.

In the "graveyard" tests at Dehra Dun it did not survive for 12 months. The heartwood is naturally durable to a good degree, but there do not seem to be any reliable service records from which accurate conclusions as to its durability can be drawn. The heartwood is very refractory to treatment with preservatives, but the sapwood treats fairly readily.

Working qualities.—Usually an easy wood to saw and work. It can generally be turned or worked by hand to a beautiful finish, and it takes a high polish, which enhances the grain and colour of the wood. Sometimes wood with badly interlocked fibres is inclined to tear up under a plane. In sawing, the gum in the wood sometimes causes trouble, and saws are liable to gum up if gum is present in excessive quantities. Apart from this, it is an extremely pleasant wood to work.

Uses.—Jhingan is a well known "local" wood, and is used in a small way over a large part of India, but it is not a wood of which one sees large quantities in any one place. It is used for housebuilding, furniture, agricultural implements, water pipes and troughs, dugouts, boat-building, carving, turnery and many other purposes. The sapwood has been used for match work, but is rather hard for the purpose. Found very suitable for cutting blocks, boot trees, boot lasts, and brush work. Has also been used for pencils, but is really too hard for this purpose without artificial softening. Proved useful as a roller wood in jute mills, and might do very well as a treated sleeper as it is a steady wood and not liable to cracking. A timber which, if well seasoned, has possibilities in many directions.

Sources of supply.—One of the commonest trees of the plains forests of India, but never gregarious in large quantities in any one place. Most Forest Divisions of the United Provinces, the Central Provinces, Bengal, Bihar, Orissa, and Madras could supply limited quantities on demand. Local timber dealers and contractors would always be ready to supply this timber if asked to do so.

Prices.—The available supply of *jhingan* is usually in excess of the demand, and it is, therefore, available at very moderate prices. Bengal, the United Provinces, Bihar, the Central Provinces and Madras all quote prices at about Rs. 22 to 30 per ton for average logs, with slightly higher prices for logs of very fine quality (1937).

Mangifera indica.

Trade name.—Mango.

Vernacular names.—*Am, amba, mavoo* (Coorg). Burmese name: *thayet.*

Weight.—38 to 43 lbs. per c. ft. (air-dry).

Description of the wood.—A grey or greyish-brown wood without any strong characteristic feature. No taste or smell. Rather coarse-textured with occasional interlocking of fibres and curly grain. A medium weight, fairly strong wood which can be used for a variety of purposes. A very steady wood and one which retains its shape extremely well.

Seasoning.—A fairly easy wood to season. It usually dries out quickly with little degrade. Very wide planks may have a tendency to split down the centre, but otherwise mango usually seasons with very little deterioration. It is however a wood which is rather prone to fungal stains, and sometimes to decay, but with quick drying these dangers can be avoided. Green conversion, followed by careful stacking in a well ventilated place so as to allow the timber to dry quickly, is the procedure to adopt. Vertical stacking in the open for quick-drying can also be adopted with advantage in damp localities where conditions are favourable for fungus infection. It can be kiln-seasoned without any trouble.

Strength.—Mango is a fairly strong wood and in this respect, is better than most people imagine. In weight it is very slightly lighter than teak and in shock resistance and shear it is equal or slightly better than teak. In other strength functions it is about 80 per cent the strength of teak. One feature about mango which is worthy of special mention is its ability to retain its shape after seasoning. It is a very steady wood when seasoned, and is actually almost as good as teak in this respect, which is rather a remarkable fact.

Durability.—Not a very durable wood in exposed positions. It is very liable to fungal staining and decay and is not immune to white ant attack. In the Dehra Dun "graveyard" tests, the 6 specimens under test were destroyed in about $2\frac{1}{2}$ years. It is an easy wood to treat with preservatives, and absorbs up to about 17 lbs. of antiseptic per c. ft. under pressure. It is therefore a timber worth consideration for a variety of purposes where treatment can be given.

Working qualities.—Mango presents no difficulties in so far as sawing and working are concerned. It can be easily finished to a clean surface, and with proper filling takes a good polish.

It can be used to advantage for rotary veneer work and plywood making, and is one of the woods being used for this purpose all over India.

Uses.—The quality of mango logs in North India and of those in the South West seems to vary considerably. The trees in the South produce magnificent long straight boles of good girth, and the wood of South Indian mango is, therefore, much sought after and is usually of excellent quality. Mango logs in other parts of India are not usually of such fine quality. It is, nevertheless, a wood which is extensively used in almost every part of India. Its chief uses are for cheap furniture, planking, floor and ceiling boards, tea chests and other box and crate work, boat-building, agricultural implements, parts of carts, tonga hood frames and, recently, for plywood manufacture. It is a good wood for dry cooperage and shoe heels.

Sources of supply.—Mango is a tree which is found in both forests and fields throughout the greater part of India. Taken as a whole, therefore, the output of it could be enormous, but supplies in any one locality are limited, and it would normally be difficult to obtain more than a few hundred tons per annum without covering a very large area. Small supplies are available almost anywhere, and enquiries should be addressed to local timber dealers, or to the nearest forest officer.

Prices.—Prices for mango depend to a large extent on quality. A mango log may vary from a magnificient stem 40 or 50 ft. long by 9 ft. girth to short illshapen logs of little worth. Madras quotes Rs. 44 per ton for their best logs, while Bombay even goes up to Rs. 80 per ton for really fine specimens. Bihar, Orissa, the Central Provinces, the United Provinces, Bengal and Coorg give prices ranging from Rs. 15 to Rs. 50 per ton in log form according to size and quality (1937).

Mesua ferrea.

Trade name.—Mesua.

Vernacular names.—Nahor, nageswary (Nepal and Bengal) *nangal* (Tam), etc. Andamans: *gangul.* Burmese name: *gangaw.*

Weight.—60 to 67 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood creamy-white, rather wide. Heartwood dark brick-red or reddish brown, dulling on exposure. No odour or taste. Medium texture and straight or interlocked grain. A very heavy, very hard, strong wood of no outstanding or ornamental features.

Seasoning.—A slow and difficult wood to season. It is prone to surface cracking, and some warping and splitting, if not carefully handled. It should be dried out slowly under cover, protected from hot winds and other drying agencies. If the above procedure is adopted, *mesua* can be air-seasoned without excessive degrade, but it must be given ample time and mild conditions.

Strength.—One of the hardest and strongest woods in India. It is about 50 per cent. stronger than teak in all strength functions, and more than twice as hard. An admirable timber for use where very great hardness and strength are required. Its strength qualities can be seen in Appendix I.

Durability.—A timber of natural durability well above the average. It lasts for 12 to 14 years as an untreated sleeper, and is rarely attacked by white ants or fungus for a number of years even in bad localities. In the "graveyard" tests at Dehra Dun 10 out of the 12 specimens installed in the ground are still in fair condition after 6 years.

Working qualities.—A difficult wood to saw, being extremely hard. Should be sawn green, as seasoned wood is so hard as to defeat most sawyers. Can be worked with tools, but is inclined to rough up on machines and, therefore, requires a good deal of work to bring it to a good surface. It is not a workshop wood, and is normally used for rougher work after being rough sawn or adzed to shape.

Uses.—The chief uses of *mesua* or *nahor* as it is commonly called, in the past have been railway sleepers, bridging, and as posts and beams in construction. It is also used for cart-building, boat-building (keels, helms and masts), pit-props, mining construction and piles. Where great strength and hardness, combined with good natural durability, are required, *nahor* is a good wood for the purpose. It should do well for road paving blocks, and block flooring in godowns and mills.

Sources of supply.—Assam has the largest supplies, and 1,500 tons are available from that Province annually in logs up to 30 ft. long and 4 ft. girth. Madras, Coorg and Cochin State can produce good amounts annually, and Bengal can produce small quantities from Chittagong. Enquiries should be addressed to the Forest Utilization Officers of Assam, Madras and Bengal or the Chief Forest Officer, Coorg.

Prices.—Assam quotes Rs. 38 per ton for logs and Rs. 1-8-0 per c. ft. for sawn timber. Madras estimates are higher at Rs. 75 to Rs. 90 per ton, while Coorg offers *nahor* at Rs. 7 per candy of $12\frac{1}{2}$ c. ft. at forest depots (1937).

Michelia species.

(*M. champaca*, *M. excelsa* and others).

Trade name,—Champ.

Vernacular names.—Champak, champa, tita sopa. Burmese name: *saga* or *sagawa.*

Weight.—31 to 34 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood narrow and whitish or pale grey. Heartwood yellowish brown or olive brown. No taste or odour. Straight-grained and of medium texture, lustrous, and with a smooth feel. Excellent light-weight woods of good quality which would command good prices in Calcutta if constant supplies could be extracted.

Seasoning.—These woods can be seasoned without difficulty or degrade, if they are properly handled. Logs should be converted green and the converted material should be stacked in a sheltered place or well ventilated shed. The wood dries quickly, and some three-quarter inch boards air-seasoned at Dehra Dun from 130 per cent. to 8 per cent. moisture content in under a month, in the hot weather, and the seasoned timber was in excellent condition. Kiln-seasoning presents no difficulties, but kiln-seasoned wood seems to lose colour during the process of drying, and is inclined to become dull.

Strength.—The woods of *Michelia* species seem to be all very similar in weight, hardness, and strength functions. They are about 25 per cent. lighter than teak and about 20 to 25 per cent. weaker. In hardness they have only about 60 per cent. the hardness of teak.

Durability.—The *Michelias* are not usually very durable woods, although there are records of their having lasted for a very long time as posts and in water. In the "graveyard" tests at Dehra Dun, all the specimens of *Michelia champaca* and *Michelia excelsa* under test were destroyed by fungus within 3 years. *M. montana* did much better in these tests, and 5 out of 6 specimens were still in fair condition after $4\frac{1}{2}$ years. In experiments done at Dehra Dun *champ* was found difficult to treat in the heartwood.

Working qualities.—Straight-grained woods which are very easy to saw, machine, and finish. They work to a beautiful smooth surface and are attractive woods to handle. They take stain and polish nicely. They turn well, and can be peeled into excellent veneers for plywood, but the wood is without much character or figure, and rather dull for decorative or panel work.

Uses.—Excellent timbers for light furniture and house hold fitments. Considered in Assam to be first class woods for a variety of purposes. They are used for boards and general joinery work, cabinet making, boat-building, box shooks, and bent-wood work. They are on the weak side for heavy constructional purposes, but as treated ceiling or floor-boards, painted panelling and household fitments they would be excellent. Special tests indicate that all Indian *Michelia* species may make good substitutes for Sitka Spruce for aircraft work.

Sources of supply.—The main supplies come from Assam and Bengal, in fact these are the only two Provinces producing commercial supplies, apart from Burma which has small quantities which are not much exploited. The demand usually exceeds the supply, in fact Calcutta would probably be able to absorb far larger quantities if they were available. Enquiries should be addressed to the Forest Utilization Officers, Assam and Bengal.

Prices.—Assam quotes Rs. 50 per ton for logs up to 18 ft. length and 6 ft. girth, and Rs. 1-10-0 per c. ft. for sawn squares. Bengal quotes Rs. 35 to Rs. 45 per ton in log from Kurseong, Buxa and Darjeeling Divisions (1937).

Mitragyna parvifolia.

(Syn. *Stephegyne parvifolia.*)

Trade name.—*Kaim.*

Vernacular names.—*Amsabita, kalikadamba* (Bih), *hedu* (Hyd.). Burmese name: *tein.* (Burmese name for *M. diversifolia* is *binga.*)

Weight.—39 or 40 lbs. per c. ft. (air-dry).

Description of the wood.—A pale yellow wood when freshly sawn. The colour tones down to a light brown on exposure. No characteristic odour or taste. Usually straight-grained but sometimes with wavy grain. Fine even texture and smooth feel. A typical turnery wood of fair quality but not quite up to the standard of a wood like *haldu.*

Seasoning.—*Kaim* is rather liable to develop fine wavy surface cracks and splits at knots, but the degrade from these is not excessive if the timber is dried with care slowly. Green conversion, followed by stacking in a sheltered place to prevent too rapid drying, is the method of air-seasoning recommended for this species. It can be kiln-seasoned with fair success, but, here again, care must be taken to dry the timber out under mild conditions if surface-cracking is to be avoided.

Strength.—This wood is a shade lighter than teak but of the same hardness. In strength it is about 25 per cent. weaker than teak, except in shock resistance and shearing strength, in which it is about equal to teak.

Durability.—Not a very durable wood, but on the other hand not a very perishable timber. In the "graveyard" tests at Dehra Dun, it lasted about 4 years before being destroyed by fungus and white ants. In preservative treatment *kaim* is inclined to be erratic, penetration in the heartwood of some pieces being complete while in others it is patchy.

Working qualities.—An easy wood to saw and sometimes easy to machine and work to a smooth finish, but if wavy or broadly interlocked fibres are present, the wood is inclined to pick up, and as a result, needs considerable work to bring it to a smooth surface. It takes a fine polish and stains easily. Has not been tried for veneers or plywood, but is probably more suited for slicing than for rotary cutting.

Uses.—This wood is fairly commonly used for such purposes as toy-making, turnery, and the manufacture of combs, cups, platters, bowls, frames, walking-sticks handles and such like articles. It is fairly popular for turnery work and carving, and it is

not uncommonly seen as planking and for furniture (bed legs). It is recommended for certain types of bobbins, for penholders, and mathematical instruments.

Sources of supply.—Kaim is usually found as a scattered tree, and large supplies in any one place are not available. The United Provinces and Bihar can both supply a certain amount, while Bombay, Madras, and Orissa could also provide smaller supplies on demand.

Prices.—The United Provinces quote Rs. 25 per ton for good quality logs, and Bihar quotes from Rs. 22 to Rs. 30 per ton in log form (1937).

Morus species.

(*M. alba* and *M. lævigata.*)

Trade name.—Mulberry.

Vernacular names.—*Tut, tutri.* Andamans: *posa.* Burmese name *posa-tawposa.*

Weight.—38 to 42 lbs. per c. ft. (air-dry).

Description of the wood.—*M. alba* is now recognised as the species grown in the Punjab irrigated plantations. Formerly it was thought that this species was *M. indica.* Some botanists think the two are synonymous. *M. leavigata* is the common mulberry of Bengal and Assam. The two woods are very similar in appearance. The sapwood is white and sharply delimited from the heartwood, which is a bright yellowish brown when freshly cut, but the colour quickly tones down to a duller brown on exposure. No odour or taste. Straight-grained and of rather open medium-coarse texture.

Seasoning.—Mulberry is not a difficult wood to season, but it has a tendency to warp. It is said that this can be overcome by quartering the logs and omitting the heart-centre from a scantling The best results have been obtained by storing the log or quartered logs for some months before final conversion, care being taken to protect the ends with some moisture-retardant composition to slow down drying, a very necessary precaution in localities in the Punjab where scorching dry winds are experienced. *M. laevigata* seems to season more easily and with less degrade than *M. alba.* Both woods can be kiln-seasoned without difficulty or degrade. In practice, the majority of the mulberry used in the Punjab is used in a green state by the sports goods manufacturers. The timber is converted green, steam bent, and then dried out in a bent form tightly held in a clamp. It reacts to this treatment with amenity.

Strength.—Mulberry is approximately the same weight as teak, and in shock resistance, shear, and hardness it is considerably higher than teak. In other strength functions it is a little below teak. It is a wood admirably suited for the purposes for which it is used, namely sports goods such as hockey sticks and tennis rackets, where its shock resisting ability and high shear quality can be used to advantage. Its strength qualities can be seen in Appendix I.

Durability.—Timbers of moderate durability. In the "grave-yard" tests at Dehra Dun, the best specimens lasted for 4 years under very bad conditions before they were destroyed by white ants. They were not touched by fungus to any appreciable extent.

Mulberry has not been tested for preservative treatment, but from the structure of the wood, it would appear to be a timber which should treat fairly readily.

Working qualities.—Easy woods to saw and work to a clean finish by hand or machinery. Can also be carved and turned to a smooth surface. Excellent woods for steam-bending. They can take a right angle bend without any signs of cracking. Cut on the quarter they present quite a fine silver grain. They also peel well on a rotary lathe and make up into good commercial plywood.

Uses.—The primary use for mulberry, especially in North India, is for sports goods, for which purpose it is eminently suitable. It is becoming better and better known throughout Europe and America, and is now preferred by a lot of buyers to European and American ash for hockey sticks. It is also used in India for tennis rackets, badminton and squash rackets, presses, cricket stumps and similar purposes. It is an excellent wood for furniture, especially camp furniture, picker arms, and carriage building, and if supplies were more abundant, it would be one of the most universally used woods in India. A laminated "gipsy" airscrew passed bench tests.

Sources of supply.—Apart from the small natural forest supplies of *M. laevigata* and other *Morus* species, the main source of supply of mulberry is from the irrigated plantations of the Punjab. Changa Manga is at present the chief of these, but other plantations are growing up and will help to add considerably to the output of mulberry before very long. The demand for mulberry at present exceeds the supply, and the sports goods industries, both in India and other countries, could absorb far larger amounts than those at present available.

Prices.—The price of mulberry at Changa Manga ranges from about Rs. 2 to Rs. 3 per c. ft. for average quality logs of about 6 ft. length and up to 3 ft. girth, according to size and quality.

Olea species and Parrotia jacquemontiana.

Trade names.—Olive and *parrotia.*

Vernacular names.—*Kow, kao* (*Olea* spp.), *pohu* (*Parrotia*).

Weight.—Olive weighs about 60 to 70 lbs. per c. ft. and *parrotia* about 46 to 58 lbs. per c. ft. (air-dry).

Description of the wood.—Olive and *parrotia* are very hard, heavy, close-grained, strong, elastic and tough woods, and as they both occur as small trees in approximately the same areas, and as they are both used for the same purposes, they have been classed together for the purposes of this book. The sapwood of olive is pinkish or greyish white. The heartwood varies, but is usually clear brown with a greenish or even pinkish tinge. The heartwood of *parrotia* is usually a darkish grey. The texture of both is very fine and even, and the grain is usually straight. No distinct odour or taste. Olive heartwood can be extremely handsome, but as neither wood is obtainable in very large sizes, they must be looked upon as utilitarian rather than ornamental woods.

Seasoning.—With olive, care has to be taken that the wood is protected from too rapid drying if cracks are to be prevented. Close-piling under cover, and end-painting of planks or billets are recommended; *parrotia* seasons more easily. Drying close-piled under cover with the ends of planks or billets end-painted is also recommended for this species, but open stacking can be used with *parrotia.* Both woods can be kiln-dried, but mild conditions are necessary.

Strength.—Both woods are hard, strong, tough, and elastic, and are eminently suitable for shock resistance, and, therefore, for use as tool handles. Olive is equal to good quality ash for this purpose, and *parrotia* is even slightly stronger than ash and approaches hickory in strength functions.

Durability.—Olive has a fairly good natural durability, but *parrotia* cannot be classed as a durable wood. This, however, is not of great importance, as it is not used for purposes where great durability is required.

Working qualities.—Both woods are fairly easy to saw and work. They turn and finish to a beautiful surface and take a high polish. Sometimes, if olive has interlooked or wavy grain, the fibres are inclined to pick up slightly, which may mean extra work to bring it to a smooth surface, but being of very close and fine texture, this can usually be accomplished without any undue labour.

Uses.—Both woods are pre-eminently suitable for tool handle and similar work. They occur in small sizes, in fact *parrotia* is often only obtainable in billet form, and they are, therefore, excluded for other uses where larger sizes are required. They are accepted by the railways and others for tool handles of all kinds, and are in common local use for turnery work, walking sticks, toys and carving. Olive makes an excellent police baton and, being very ornamental, could be used for inlay work, and possibly as a sliced veneer for decorative purposes.

Sources of supply.—The demand for olive is fairly extensive and supplies are limited. It occurs in the Punjab in Rawalpindi Division, and in Kashmir in Ramban Division, from where limited supplies are available in small logs up to 2 ft. to 2½ ft. girth. *Parrotia* is more plentiful, but in smaller sizes, usually in billet form. The North-West Frontier Province can supply fair quantities and Kashmir can supply large quantities.

Prices.—Enquiries as to prices should be addressed to the Chief Conservator of Forests, Punjab or Kashmir, or the Conservator of Forests, North-West Frontier Province. These woods are usually sold in billet form at so much per billet, per lb. or per score.

Ougeinia dalbergioides.

Trade name.—*Sandan.*

Vernacular names.—*Bandhan, panjan,* (Bihar), *tinsa* (C. P.). *tiwas* (Berar.)

Weight.—About 54 or 55 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood light grey, narrow. Heartwood a greyish brown or light reddish-brown, sometimes mottled but more usually without character. No taste or smell. A heavyish wood with bands of interlocked fibres. Rather coarse texture. Large logs usually have unsound centres, which should be cut out during conversion.

Seasoning.—Air-seasons slowly, but without much difficulty or degrade. A certain amount of surface cracking may be expected if the wood is dried under adverse conditions. Green conversion, followed by careful stacking under cover in a well ventilated place will usually give good results. Unsound hearts should be "boxed" during conversion. Can be kiln-seasoned without any difficulty.

Strength.—*Sandan* is a very hard wood and is very much harder than teak. It also stands shearing stresses to a remarkable degree, due no doubt to the interlocking of the fibres. In other strength functions it is about equal to teak, but it is a good deal heavier.

Durability.—A wood of fairly high natural durability. In the "graveyard" tests at Dehra Dun, the 6 specimens tested lasted ten years. They had been attacked by white ants but not very seriously. Other writers usually refer to *sandan* as a wood of natural durability well above the average. It has not been tested for penetration with preservatives, and may be difficult in this respect owing to the pores being filled with a gummy deposit.

Working qualities.—The wood is hard and, therefore, correspondingly difficult to saw and work. It can, however, be brought to a fine finish. It planes and turns well, but is hard on the cutters. The presence of interlocked fibres means a certain amount of care and labour to produce a smooth surface, but once finished it has a good surface which takes polish readily. It has not been tried for veneers or plywood, and is probably too hard for the purpose. The interlocked fibres would also probably cause trouble in peeling.

Uses.—Being tough and strong, *sandan,* is a good wood for cart-building, tool handles, axe helves, picker arms, agricultural instruments and constructional work. It has also been found very good for tight and loose cooperage. It is a little heavy for

furniture, but it is used for this purpose, and selected stock can be quite ornamental. It is a wood which is already well known in the localities where it occurs, and one which is popular for many local purposes.

Sources of supply.—Sandan is a fairly common tree in the plains' forests of India, but, where large stems are found, it has already been overworked. In localities where the tree is small, fairly large supplies could be made available in small sized logs. The best logs come from the West Coast forests of Bombay. The Central Provinces, Bihar, Orissa, and the United Provinces can all supply varying quantities. Enquiries should be addressed to the Conservator of Forests concerned, or the Forest Utilization Officers of the above Provinces.

Prices.—Bombay quotes up to Rs. 145 per ton for really good quality logs, and the Central Provinces quote from Rs. 75 to Rs. 125 per ton in the log according to size. Bihar and Orissa prices are lower, ranging from about Rs. 30 to Rs. 60 per ton. In the United Provinces only small quantities are available in small sizes up to about Rs. 25 per ton (1937).

Phœbe species.

Trade name.—Bonsum.

Vernacular names.—Makroi, angare (Nepal). Sometimes called Assam teak, but this is a misleading name as it has no relation to teak, except possibly in colour. Burmese name *sicknana hlega*

Weight.—About 34 to 30 lbs. per c. ft. (air-dry).

Description of the wood.—There are several *Phœbe* species in Assam and Bengal, *P. hainesiana*, *P. attenuata* and *P. goalparensis* being amongst the most common. The sapwood is greyish white. The heartwood, when freshly sawn, is a pale greenish buff, but this tones down fairly quickly to a rich brown, the colour of teak wood, which is perhaps the reason why *bonsum* is sometimes marketted under the name of Assam teak. No distinct odour or taste. Slight cross-banding and fairly even texture. Excellent light weight timbers which can be used for a variety of purposes.

Seasoning.—Bonsum seems to give very little trouble in seasoning, and when dry is a very steady wood. Furniture made at Dehra Dun out of some wide planks of *P. hainesiana* has remained for several years without a sign of a crack or other defect. On the other hand, reports have been received that some consignments of *bonsum* have given trouble in seasoning, but the quality of the wood appears to have been poor to start with and there was also some doubt as to the species concerned. In veneer form, *bonsum* dried out from 60 per cent. to 4 per cent. moisture content within 15 minutes in a dryer without any degrade. Green conversion and stacking under shelter with a good air circulation is advocated. Kiln-seasoning presents no difficulties, the timber coming out in perfect condition.

Strength.—P. hainesiana is about 20 per cent. below teak in all strength functions. In hardness it comes out at about 70 per cent. the hardness of teak. Other species have not been officially tested at Dehra Dun, but they are probably a little stronger than *P. hainesiana*, which is a good light-weight wood, but not one to use where great strength is required.

Durability.—P. hainesiana did comparatively well in the "graveyard" tests at Dehra Dun. The six specimens were destroyed in 7 years, while other specimens of *Phœbe* spp. were destroyed in 1-3 years. The *bonsums* can probably be classed as moderately durable woods, but they should not be used in outdoor positions without preservative treatment which they take fairly

well, the heartwood usually becoming mottled or treated in patches.

Working qualities.—Extremely easy woods to saw and work. They can be brought to a fine smooth surface with very little labour, and though not very ornamental, look well under a wax polish. *P. hainesiana* has been tested for rotary cut veneers and plywood and the reports on it were most favourable. It was found suitable, in every way for plywood work, and when the plywood was tested in the form of tea chests, it gave exceptionally good results. In short, *bonsum* is a most satisfactory and pleasant wood to handle and work in every way. A laminated "gipsy" air screw has passed flight tests.

Uses.—Up till a few years ago, *bonsum* does not seem to have been known to any large extent outside the areas where it grows. Of recent years, however, it has been brought to the notice of several users, and they all seem pleased with it and report favourably on it. It makes an excellent light box wood, and is becoming popular for light furniture, cabinet making and general joinery. It has been found very useful for gramophone cabinet work, and has been used by the Ordnance Department for soldiers' boxes and other purposes. It is also a good pattern wood and is used in some large foundries for this purpose.

Source of supply.—In practice it is not possible to differentiate between the various *Phoebes*; but *P. goalparensis* is by far the most common. Supplies are limited in Bengal but Assam can produce fairly good quantities. The demand is growing and will probably increase still further. Good logs up to 24 ft. length and 5 ft. girth are available. Enquiries should be addressed to the Forest Utilization Officer, Assam.

Prices.—Assam quotes about Rs. 45 or Rs. 50 per ton for logs, and Rs. 1-8-0 to Rs. 1-10-0 per c. ft. for sawn material (1937).

Picea species.

(*P. morinda* and *P. smithiana.*)

Trade name.—Spruce.

Vernacular names.—*Rai, kachal, partal* (Punjab).

Weight.—From 21 to 39 lbs. per c. ft. the average being 29 lbs. per c. ft.

Description of the wood.—White or buffish white, with little differentiation between sapwood and heartwood. A false red "heartwood" is found in some trees. Very slight resinous odour. Straight-grained and of even texture. Colour tones to a dull greyish-brown on exposure. A good quality light weight wood of the "deal" class.

Seasoning.—Spruce is not a difficult wood to air-season if treated properly. It should be dried in open stacked piles under cover where it is not exposed to the direct rays of the sun or scorching winds. If dried too quickly it is apt to develop fine long splits. It is a timber which is prone to fungal attack and care must be taken to avoid this, which can be done by stacking converted timber well off the ground immediately after conversion. Kiln-seasoning presents no difficulty with this wood, it is, in fact, essential if the timber is to be used for aircraft work.

Strength.—Being a light-weight wood, spruce is not amongst the very strong woods of India, but weight for weight it is a relatively strong wood, and where a light but relatively strong wood is required, it is hard to find a better timber for the purpose. It is about 30 to 35 per cent. lighter than teak and about 65 to 75 per cent. the strength of teak in most functions. It is one of the few Indian woods which would be accepted for aircraft work if freedom from fungus attack could be assured.

Durability.—Spruce is not a durable wood, in fact it is very liable to be attacked, especially when green, by fungus. Unfortunately it is a difficult wood to treat with preservatives, and even under severe pressure treatments a side penetration of only about one quarter of an inch can be procured. It is usually incised before treatment as a sleeper, and this results in a fair peripheral layer of treated wood on the outside of the sleeper, but it is not a very satisfactory treatment.

Working qualities.—An extremely easy wood to saw and work. Like most Indian conifers, it is apt to have an excessive number of large knots, and this detracts from its value as a carpentry wood. Except for this, it is a pleasant and easy wood to work with and it can be brought to a good finish. It has been tried for

rotary cut veneers but was found unsatisfactory. The fibres of the wood tore up along the annual rings during the peeling process. The knots also caused trouble and even chipped the knife.

Uses.—Indian spruce is well known amongst timber dealers in Northern India, and is used for planking in ceilings and floors, general joinery, cheap furniture, boxes and crates. The bulk of the supply, however, goes to the railways as treated sleepers. It is one of the few Indian woods suitable for making good quality wood pulp, and it will no doubt be exploited for this purpose as time goes on. It is one of the best light box woods in India, but unfortunately the supplies are too far distant for profitable exploitation in the large commercial centres of Calcutta and Bombay.

The question as to whether Indian spruce can be used in place of sitka spruce for aircraft work, is under examination. The Research Institute has shown that small clear specimens give strengths equal, or superior, to sitka spruce. It remains to be seen whether it is possible to obtain timber of this quality in the requisite sizes, it is this feature of the problem which is under examination.

Sources of supply.—Spruce is usually marketted together with silver fir as one timber, in the form of sleepers. In fact, except for a few logs extracted from Kashmir to Jhelum depots, all the spruce and fir extracted in India comes out in sleeper sizes. It is available only in Northern India, and enquiries should be addressed to the Chief Conservators of Forests, Punjab, United Provinces, or Kashmir.

Prices.—The Punjab quotes 8 annas to 11 annas per c. ft. for sawn material at river depots (1937). The price of logs is usually about Rs. 25 to Rs. 35 per ton (1937).

Pinus species.

(P. longifolia and *P. excelsa.)*

Trade names.—Chir (P. longifolia); blue pine *(P. excelsa).*

Vernacular names.—Chil (P. longifolia), kail, partal, nishtar (P. excelsa).

Weight.—Chir, average about 38 lbs. per c. ft.; blue pine, average about 32 lbs. per c. ft.

Description of the wood.—Sapwood yellowish-white. Heartwood yellowish or reddish buff. Characteristic resinous odour. Usually straight-grained. Twisted fibred *chir* is common in a few localities, but wood from these areas is usually not exploited. Texture variable from fine to coarse. Large knots usually present in excess. Good quality medium weight woods of the "deal" class. Next to *deodar*, *chir* is the most used wood in Northern India. Blue pine is a slightly superior wood to *chir*.

Seasoning.—Easy woods to season. If they are stacked in well ventilated open piles, preferably under cover or shade, they will dry out without any appreciable degrade. If stacked out in the open in the full sun, a certain amount of cracking and splitting can be expected, and if close-piled in a damp atmosphere, fungus attack results. Both timbers can be kiln-dried without difficulty.

Strength.—There is little to choose between the strength of *chir* and blue pine. The latter is usually slightly lighter than the former, both being about 75 per cent. the weight of teak. *Chir* from the Punjab, tested at Dehra Dun, proved to be a good deal stronger than *chir* from the United Provinces. Whether or not this holds good for all consignments it is difficult to say. Both are reasonably strong woods for their weight.

Durability.—Neither *chir* nor blue pine are very durable woods, and for sleeper or other outdoor work they should be treated with a preservative. *Chir* sapwood treats readily but the heartwood is variable in this respect. Sometimes complete penetration is obtained, while at other times penetration is patchy and poor. *Kail* is more difficult to treat and so far it has not been possible to obtain really good penetration in this wood.

Working qualities.—Easy timbers to saw and work, and usually very popular woods in any workshops. They can be brought to a fine smooth surface, but are more suitable for paint and enamel finishes than for polish work. Good quality woods of the "deal" variety.

Uses.—Chir and blue pine are well known in the Punjab and United Provinces as useful joinery woods. When treated with a

preservative they make good railway sleepers, with a life of about 16 or 17 years. Also used for shingles, packing cases, constructional work, light furniture and house fitments. Blue pine is usually considered to be a slightly superior wood to *chir* for most purposes, but there is little to choose between them. They are good woods for pattern making, cores for laminboards, drawing boards, and plane-tables, but neither is suitable for commercial plywood work.

Sources of supply.—Both *chir* and blue pine are usually brought out from the Himalayan forests in sleeper form, but logs are sometimes obtainable at river depots. Supplies are plentiful, and enquiries should be addressed to the Chief Conservator of Forests, Punjab, and United Provinces, or the Conservator of Forests, North West Frontier Province.

Prices.—The current price of 12 ft. blue pine B. G. sleepers is Rs. 4-10-0 to Rs. 4-13-0 per piece. The price of 9 ft. *chir* sleeper is about Rs. 3-4-0 per piece (1938). The price of logs varies from about Rs. 25 to Rs. 40 per ton according to size and quality.

Pterocarpus dalbergioides.

Trade name.—Andaman *padauk.*

Vernacular name.—*Padauk.*

Weight.—43 to 48 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood greyish or dirty white. Heartwood usually bright red, dulling to dark red or brown on exposure. Varieties shading from golden yellow to dark blood red are not uncommon, the lighter varieties being known as "off-colour" *padauk.* Often finely marked with dark streaks and mottling. No odour or taste. Broadly interlocked grain and rather coarse texture. An extremely strong, handsome, and steady cabinet or constructional wood.

Seasoning.—Andaman *padauk* presents no difficulties as regards seasoning. If carefully piled in open stacks under cover or in the shade, with a good air-circulation through the stacks, it will dry out fairly quickly with very little depreciation. It is equally amenable to kiln-seasoning.

Strength,—Andaman *padauk* is usually slightly heavier than teak, and also slightly stronger. In hardness it exceeds the hardness of teak by 30 per cent. Taken as a whole it may be described as a very strong wood, and one which is, possibly, slightly better than teak in retaining its shape after drying. This is rather a remarkable feature as it is rare to find an Indian wood which even approaches teak in this respect.

Durability.—A very durable wood. It usually remains untouched by white ants for a very long time, and it is not subject to fungus attack. In the "graveyard" tests at Dehra Dun, the 6 specimens under test were still under test at the end of 16 years being moderately to badly attacked by white ants. The sapwood can be treated, but the heartwood is refractory to preservative treatment.

Working qualities.—Andaman *padauk* is not difficult to saw and machine, but the bands of interlocked fibres necessitate some extra work to bring it to a good finish. It can be worked to a fine surface, and after proper filling, it takes a good polish or wax finish. It is not suitable for rotary cut veneer work as the veneers contain uneven patches of interlocked fibres. It could, however, be used to advantage for sliced or sawn veneers. Selected stock can be extremely handsome,

Uses.—Andaman *padauk* is already well known in both Indian and European markets. It is a first class cabinet wood and a

fine strong constructional timber. It is especially suitable for heavy carpentry, such as for billiard tables, railway carriage work, ships cabins and saloons, and high class furniture generally. It makes an excellent parquet floor wood, and is one of India's steadiest and most decorative woods. It was used for counters in the Bank of England. It has been used by the R. A. F. for making " Cyclone " and " Merlin 20 " test fans. In the earlier days of aviation an aircraft, fitted with a *padauk* propeller held the world's altitude record.

Sources of supply.—The sole source of supply is the Andaman Islands. Fine large squares are obtainable and the output is large. European and American quality squares have a face of 24" × 24" and up. The Indian specification is 12" × 12" and up × 12' and up. Enquiries should be addressed to the Chief Forest Officer, Port Blair, Andaman Islands.

Prices.—The price of Andaman *padauk* fluctuates with other market prices. The current price is from Rs. 95 to Rs. 100 per ton for squares, and Rs. 100 to Rs. 150 for scantlings according to size and quality (1937). For European quality squares the price landed in Calcutta is about Rs. 180 per ton.

Padauk burrs.—Andaman *padauk* trees not infrequently produce large burrs, the wood of which is often extremely handsome. Anyone interested in this burr wood should apply to the Chief Forest Officer, Andamans, for samples and quotations.

Pterocarpus marsupium.

Trade name.—Bijasal.

Vernacular names.—Piasal (Bih.), *vengai* (Tam), *honne* (Coorg and Kan.).

Weight.—48 to 50 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood creamy-white. Heartwood pale golden brown, often with darker markings, toning to a darker shade on exposure. Staining yellow when damp. No taste or smell. With broadly interlocked grain and of medium texture. A moderately heavy carpentry and constructional wood of good quality, but of no outstanding beauty.

Seasoning.—The wood seasons easily, and develops few defects. A few surface cracks or splits may develop but they are usually not numerous nor of a very serious nature. Green conversion followed by seasoning in open piles under cover is the best procedure to adopt. The heart is often unsound and should be "boxed" during conversion. If this is not done splits will result. The timber can be kiln-seasoned easily without degrade. In kiln-drying, the colour of the wood usually tones down to a rich brown.

Strength.—Bijasal is a fairly heavy, strong and hard wood. It is about 10 per cent. heavier than teak, 35 per cent. harder, and 35 per cent. above teak in shock resistance. In other strength functions it is similar to teak, but it does not retain its shape so well as *Pterocarpus dalbergioides.*

Durability.—A timber of natural durability rather above the average. In the "graveyard" tests at Dehra Dun, the 6 specimens tested were still in position at the end of 16 years, although they were fairly badly attacked by white ants. In South India this wood has a very good reputation for durability. It is a refractory wood to treat in the heartwood. The sapwood will treat fairly readily.

Working qualities.—A fairly easy wood to saw and work, but the cross-banded fibres make working to a smooth surface rather laborious. It can however be brought to a good finish, and, with ample filling, takes a good polish. Not suitable for rotary veneer work or plywood, but possibly quite a good wood for sliced or sawn veneers.

Uses.—In South India, *bijasal* grows to a large size and has a well deserved reputation as a high quality wood. It is the most popular wood for various purposes next to teak and rosewood.

In Central India, it is a smaller tree, and not so popular, although there is always a market for it. Its chief use is for building purposes. It is also used for furniture, cart-building (felloes, spokes and bent rims), agricultural implements, grain-measures, carving, pit-props and railway carriage construction.

Vessels made of *bijasal* have a popular reputation for transferring to their contents anti-diabetic qualities. Analysis of the wood has, however, proved that this supposition is doubtful, but some medical practitioners do maintain that the sugar content of the urine is reduced by drinking water from vessels of *bijasal*.

Drinking vessels of this wood can be obtained from Messrs. Shiam Mohan Bros., 67 Civil Lines, Bareilly, U. P.

Sources of supply.—Good supplies are available from the Central Provinces, Bombay, Coorg, Madras, Orissa and the United Provinces. The quality in the South is better than that from the more Northern provinces. For example, logs up to 30 ft. long and 5 ft. girth or more are available in Bombay and Madras, whereas shorter lengths and girths of $2\frac{1}{2}$ ft. to 4 ft. are more common in the Central and United Provinces. Enquiries should be addressed to the nearest Conservator of Forests of the above-mentioned Provinces.

Prices.—Bombay quotes varying prices up to Rs. 130 per ton for really good quality logs. Madras quotes Rs. 30 to Rs. 60 per ton, the Central Provinces Rs. 60 to Rs. 75 per ton, Orissa Rs. 20 to Rs. 75 per ton and the United Provinces up to Rs. 37 per ton. Coorg quotes 11 to 14 annas per c. ft. for logs (1937).

Pterocarpus santalinus.

Red sanders (*verrachandana*, Telegu), weight 76 lbs per c. ft. (air-dry), is another wood of the same genus, very similar in appearance to dark Andaman padauk, but much heavier and harder. It is extremely strong and durable. Its great weight and hardness are against it for cabinet work, but it is popular in South India for ornamental house posts, carvings, and turnery. Seasons easily and is very durable. Supplies limited. Mostly confined to the Cuddapah District.

Prices.—Rs. 40 to Rs. 175 according to size and quality.

Schima wallichii.

Trade name.—Chilauni.

Vernacular names.—Needle wood, *kanak* (Beng.). Burmese name: *thityah* or *laukyak.*

Weight.—43 to 46 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood dirty white. Heartwood light reddish-brown, sometimes with darker bands. No taste or smell. Usually with twisted and irregular grain. Medium texture. A medium weight wood of fair quality.

Seasoning.—The wood has a tendency to warp and twist while it is seasoning, and is also prone to develop cracks and splits. It is, therefore, a very refractory wood to season, and care must be taken when stacking it to see that the stacks are well built if warping is to be prevented. Green conversion followed by seasoning in well built stacks under cover, is the best procedure to adopt. It can be dried in seasoning kilns with much better results, and experiments at Dehra Dun produced kiln-dried timber with practically no degrade.

Strength.—Chilauni is of about the same weight as teak, but in other respects is below teak in all strength functions except shear. It is 15 per cent. below teak in hardness.

Durability.—Not a very durable wood. In the "graveyard" experiments at Dehra Dun, the 6 specimens under test were destroyed by fungus and white ants within 5 years. The heartwood is difficult to treat, while the sapwood is readily treatable.

Working qualities.—It saws easily and works to a smooth surface, but is not popular with woodworkers as it has the reputation of causing intense irritation to the hands when it is handled.

Uses.—The timber is used locally for constructional purposes, agricultural implements, and, in the round, as pit-props. If it could be seasoned more easily, it would probably be more popular than it is. Where kiln-seasoning is available, good use could be made of it in scantling and plank form for several purposes.

Sources of supply.—Supplies are restricted to Assam and Bengal, where it is available in large quantities in logs up to 20 ft. in length and 6 ft. girth. Enquiries should be addressed to the Forest Utilization Officers of the above mentioned Provinces.

Prices.—Bengal quotes Rs. 20 to Rs. 30 per ton for logs and Rs. 35 to Rs. 75 per ton for sawn material, from Buxa, Kurseong, Kalimpong, and Chittagong districts. Assam quotes Rs. 38 per ton for logs and Rs. 1-4-0 per c. ft. for sawn squares of 18 inch sidings (1937).

Schleichera trijuga.

Trade name.—Kusum.

Vernacular names.—Kusum, sagade (Coorg), *puvum* (Mal.). Burmese name: *gyo.*

Weight..—59 to 68 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood dirty white. Heartwood uniform dull reddish-brown. No taste or smell. With irregularly interlocked fibres. Medium texture. One of the heaviest and hardest of the Indian woods.

Seasoning.—A refractory wood to season. It is apt to develop surface cracks, and requires slow seasoning. Green conversion, followed by close-stacking under shelter and protected from hot drying winds, gives the best results. It is not a timber recommended for kiln-drying as its seasoning defects seem to be enhanced by artificial drying.

Strength.—Kusum is a very heavy, hard, strong, tough wood. It is some 60 per cent. heavier than teak and about 40 per cent. stronger. Its shear value is 85 per cent. greater than teak, and in hardness it stands almost in a class by itself, being 165 per cent. harder than teak.

Durability.—In spite of its great hardness, *kusum* is not as durable as one would suppose. On the other hand, it is not a very perishable wood. In the "graveyard" tests at Dehra Dun, it lasted for about 6 years before being destroyed by fungus and white ants. It can be treated readily with preservatives, penetration in the heartwood being more or less complete.

Working qualities.—A difficult wood to saw and work on account of its hardness. Seasoned stock is extremely difficult to saw and is apt to tear off the teeth of a bandsaw. It can be sawn slowly by hand or on a frame saw of stout gauge. It can be brought to a very fine surface and turns very well indeed.

Uses.—Kusum is a useful wood for many purposes in spite of its refractory nature. Its great hardness and toughness make it popular for oil and sugar mills, hubs of wheels, mortars, bearings and tool handles. It is also used in mines as a pit-prop and for gallery structures. If treated, it would make an extremely strong and durable constructional wood, and should be excellent for road paving and wood block flooring in mills and godowns. It is an excellent fuel wood.

Sources of supply.—Supplies are available from Bombay, Orissa, and the United Provinces. It is also common in the

Central Provinces, Bihar and Madras, but large amounts in any one district would be difficult to find as it is one of the trees cultivated for lac growing. Enquiries should be addressed to the nearest Conservator of Forests of the above mentioned Provinces.

Prices.—Bombay quotes from Rs. 10 to Rs. 45 per ton according to size and quality. Orissa quotes Rs. 28 per ton in the log, and the United Provinces up to Rs. 25 per ton (1937).

Shorea species.

(S. robusta and *S. assamica.)*

Trade names.—*Sal* (*S. robusta*); *makai* (*S. assamica*).

Vernacular names.—*Sal, makai.* Burmese names: *S. assamica* = *kyilan. S. obtusa* = *thitya.*

Weight.—*Sal*, 50 to 56 lbs. per c. ft.; *makai* 34 to 37 lbs. per c. ft. (air-dry).

Description of the wood.—The very hard cross-fibred reddish-brown wood of *sal* is too well known to most timber merchants to need much description. It is a very hard, heavy, and extremely strong tough wood, and one which is naturally very durable. No taste or smell. Interlocked fibres in broad bands and of medium texture. Probably the most extensively used wood in North, Central and East India.

Makai is a much lighter and weaker wood, and is known as one of the "soft *Shorea*" woods. It is a relatively soft wood, light brown in colour, and fairly straight-grained, with an even medium-coarse texture. A useful wood of its own class, but of an entirely different nature to *sal.*

Seasoning.—*Sal* seasons extremely slowly in scantling or sleeper form, and even after several years still contains a fairly high moisture content in the interior of the wood. It develops characteristic small surface cracks while drying out. These usually run in echelon according to the interlocking of the fibres of the wood. These surface cracks do not, however, effect the wood to any marked degree. If dried in the open under the sun and exposed to hot winds, some splitting and warping can be expected. Green conversion and slow seasoning under cover in sheltered locations give the best results.

Makai is a relatively easy wood to season, and it dries out fairly quickly without undue degrade if stacked in open piles under cover.

Strength.—*Sal* is a very heavy, hard, strong, tough wood. It is about 30 per cent heavier than teak, 50 per cent harder, and about 20 to 30 per cent stronger. In shock resistance it is about 45 per cent above teak. In the tests so far done at Dehra Dun, *sal* from the United Provinces (N. Kheri, Gorakhpur and Haldwani) and from Bengal (Kalimpong and Jalpaiguri) has proved to be stronger than *sal* from the Central Provinces (Balaghat). *Makai* is a much weaker wood than *sal* and is rated at abont 20 or 25 per cent below teak in weight, hardness and strength.

Durability.—*Sal* heartwood is a naturally durable wood, and usually remains immune to attack by white ants and fungi for a long period. The life of *sal* railway sleepers is usually taken at about 16 to 18 years. In the "graveyard" tests at Dehra Dun, the 6 specimens under test were still in place after 16 years, two being slightly attacked and 4 being moderately attacked. The sapwood of *sal* is very perishable and should not be used untreated. It treats very readily with all wood preservatives, but the heartwood is refractory to treatment. *Makai* is not a very durable wood. In the Dehra Dun "graveyard" tests all specimens were destroyed within 5 years. It is, however, treatable, penetration in the heartwood being patchy but not complete.

Working qualities.—Well dried *sal* is not a really easy wood to saw and work, but if sawn green it presents no great difficulties. When worked on machines, the fibres are inclined to pick up, but as it is more a rough constructional wood than a carpentry timber, this is of no great importance.

Makai, on the other hand, is an easy wood to saw and work, and it can be brought to a fairly good surface without any undue trouble. It is quite a suitable wood for good carpentry work.

Uses.—*Sal* ranks as probably the most used and best untreated sleeper wood in India. It is also used in enormous quantities as a constructional wood and for a variety of other purposes; such as for beams, rafters, flooring, piles, bridging, railway carriage and wagon work, carts, tool handles, picker arms and tent pegs. It can be best described as the most universally used constructional and domestic wood of North, Central and East India.

Makai, on the other hand, is little known far away from the localities where it grows. It is exploited in fairly large quantities by North Assam timber mills, and is sent down country in the form of beams, scantlings and planks, which are used mostly for housebuilding, tea-boxes and furniture. It can be peeled without difficulty on a rotary lathe and makes up into excellent plywood, which has been used by the trade for tea-box work.

Sources of supply.—*Sal* is available in very large quantities in the form of logs, sleepers, beams, scantlings and poles from the United Provinces, the Central Provinces, Bengal, Assam, Bihar, Orissa and a few districts of Northern Madras. Enquiries should be addressed to the nearest Conservator of Forests, of the above mentioned Provinces.

Makai is only available from Assam in limited quantities. Enquiries should be addressed to the Forest Utilization Officer, Assam.

Prices.—Sal prices range from Rs. 25 to Rs. 125 per ton according to size, quality and locality, the average figure being about Rs. 50 to Rs 60 per ton for good quality logs. B. G. sleepers are usually quoted at Rs. 4-8-0 to Rs. 5 per piece for 1st class stock.

For *makai*, Assam quotes Rs. 50 per ton for logs up to 18 ft. in length and 5 ft. girth. The price of sawn squares of 12 inch siding is about Rs. 1-8-0 per c. ft. (1937).

Sterculia campanulata.

Trade name.—*Papita.*

Vernacular names.—*Papita, sawbya* (Burma).

Weight.—About 21 to 25 lbs. per c. ft. (air-dry).

Description of the wood.—A uniform creamy-white wood, which however is quickly discoloured with bluish-black fungus staining if not dried immediately after felling and conversion. No odour or taste. Extremely light in weight, straight-grained and rather coarse-textured. A very useful light-weight white wood such as is required in large quantities for the box-making and match industries.

Seasoning.—*Papita* is a very perishable wood, and is especially liable to fungal staining when green. Once it is dried, it remains in a clean condition indefinitely. The main objective with this wood therefore, should be to dry it quickly. This can of course be best done in kilns, but if kilns are not available, the wood should be converted during dry weather and open-piled in a position where a free circulation of air can move through the pile. Vertical stacking in the sun gives even quicker results, and a few days vertical drying in the sun followed by open-stacking would quickly produce clean dry wood. This timber does not usually crack or split badly, even when dried quickly, but it is liable to insect attack if conditions are favourable for them.

Strength.—*Papita* has no great strength and is not a wood to to use where strength or hardness are required. It is about equal to *semul* (*Bombax malabaricum*) in strength, and is quite strong enough for light boxes, draw-bottoms, and such like work, and as cores for batten boards, but not for heavy constructional work.

Durability.—It is not a durable wood, in fact it is one of the most perishable woods in India, when green being especially liable to attack by stain and decay organisms and by insects. Once dried it is reasonably durable under cover, but if used where white ant or insect attack is liable, it should be treated with a preservative. It can be treated readily, and absorbs quite a lot of preservative even with a brush treatment.

Working qualities.—There is no easier wood to saw or work. It can almost be described under the old axiom as "cutting like butter". It machines well and can be brought to a good surface, which should preferably be varnished or painted.

Uses.—*Papita* is a very useful white light-weight wood, suitable for box shooks, matches and match boxes, cores for lamin-

boards, and similar purposes. It also makes quite a good insulation board, and has even been used as a substitute for balsa wood, but it is hardly up to the same standard as that fairy-weight timber. At present, the main supplies go to the match factories. It makes a fairly good quality match.

Sources of supply.—Only available in India from the Andaman Islands. Burma also has a good output, but most of it is consumed locally in match factories. It comes into Calcutta and is also sold in Calcutta. The cost of boards would be high because the price of logs is very satisfactory. The Andamans produce 11,000 tons, per year, all of which is used for matches; demand usually exceeding supply. Applications for supply should be addressed to the Chief Forest Officer, Post Blair Andaman.

Prices.—The current price of *papita* is about Rs. 30 per ton f.o.b. Port Blair (1938).

NOTE.—*Sterculia alata* is another very similar wood available in limited quantities in Madres (West Coast) and Bengal. If anything, it is a slightly superior wood to *papita* in the matter of strength, hardness and finishing qualities. It was however, tried by the West of India Match Factory, splints being manufactured in Port Blair. The main difficulty is that the match heads do not stick properly. Being a "sinker" it is not so cheap to handle in log form. It has a future as a packing case timber, but it must be kiln seasoned immediately on conversion, to avoid blue stain. The Andamans could supply about 11,000 tons per year in log form, or half that quantity in the form of scantlings.

Swintonia floribunda.

Trade nam,—Civit.

Vernacular names.—Civit. Taungthayet or *shitle* (Burma).

Weight.—About 38 to 41 lbs. per c.ft. (air-dry).

Description of wood.—The wood is a greyish-white colour, often with a pinkish or mauve cast. No great distinction between sapwood and heartwood. No taste or smell. Straight-grained and of medium texture. Very similar in appearance to mango wood. A good quality medium-weight light-coloured wood which can be put to several uses.

Seasoning.—Not a wood which gives any difficulty in seasoning. It is not prone to cracking or splitting, but it is liable to develop fungal stain when green, and is also liable to be attacked by borers. It is, therefore, a wood which should be dried quickly. The best procedure is to convert the logs as soon as possible after felling and stack the converted material in open piles under cover with as good air-circulation as possible. Kiln-seasoning is, of course, better than air-seasoning for a timber of this kind, and the wood kiln-dries usually in excellent condition.

Strength.—Civit is a little lighter than teak, and is about 30 per cent softer. In other strength functions it is below teak by about 20 to 25 per cent. It is a reasonably strong, medium-weight wood.

Durability.—Not a durable wood, and one which is very liable to fungal discolouration when in a green state. In the "graveyard" tests at Dehra Dun, all specimens were totally destroyed by white ants and rot within 18 mouths. It treats fairly readily with wood preservatives, penetration being complete in some pieces and partial in others,

Working qualities.—An easy wood to saw and work, and one which appears to be popular whenever it has been tried for any special purpose. It machines to a good finish and holds nails very well. It has been tried for veneers and plywood and has every indication of being very suitable for this purpose, provided the logs come to the mill clear of fungal stain and insect attack.

Uses.—Civit is a useful wood for many purposes, but on account of its greyish or pinkish colour it just fails to come up to the standard of a first quality box wood. It is popular in Chittagong for boat building and is also used for house-construction. It was approved by a large oil company for candle-

boxes, and has been used for both match splints and boxes. It is suitable for veneers and plywood, and, if treated, would be an excellent mediumweight wood for many purposes.

Sources of supply.—Available only from Chittagong in Bengal, and from Burma. Large quantities are available in good size logs up to 8ft. girth.

Enquiries should be addressed to the Forest Utilization Officer, Bengal or to Burma.

Prices.—Bengal quotes Rs. 25 to Rs. 38 per ton for logs (1937). The Burma prices are slightly lower than these.

Tectona grandis.

Trade name.—Teak.

Vernacular names.—*Sagun, sagwan* (Bih.), *tekku* (Tam), *teyga* (Coorg). Burmese name: *tyun.*

Weight.—38 to 43 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood greyish-white. Heartwood light golden brown. Teak from Burma and South India is usually fairly straight-grained and comparatively light in colour, while teak from the Central Provinces and Bombay is often darker and frequently marked with bold dark brown or almost black figuring. Freshly cut teak darkens rapidly on exposure, and when it is being seasoned. Characteristic smell (sometimes compared to the smell of old leather). No taste, but with an oily feel to the touch. Coarse-textured.

Seasoning.—A model wood for air-seasoning. It should be stacked in open piles under cover with a free air-circulation through the piles. It dries quickly and with little or no depreciation.

It can be kiln-seasoned equally easily. but care must be taken to avoid discolouration of the wood due to surface oxidation.

Strength.—In Appendix I, the combined strength figures of Burma and Malabar teak, which are to all intents and purposes the same, have been taken as the standard (100) to which all the other Indian woods described in this book are compared in percentage figures. Thus, it can be seen at a glance how teak compares with other woods, or other woods with teak. Compared with other industrial hardwoods of the world, teak is a mediumweight, strong wood of average hardness and of outstanding merit in retention of shape and durability. At the end of Appendix I some common foreign timbers have been shown for purposes of comparison.

Durability.—The heartwood is one of the most naturally durable woods of the world. It usually remains immune to white ant attack and insect attack for very long periods. It is, however, not always immune from fungus attack (rot), and in the "graveyard" experiments at Dehra Dun out of the 6 specimens tested 1 was destroyed in 4 years, 3 were destroyed in about 10 years, the remaining 2 at the end of 16 years being badly attacked by white ants and fungus. Taken as a whole though, good quality teak is very durable. The sapwood, on the other hand, is very perishable, and is usually quickly destroyed by rot, white ants or borers. The sapwood of teak appears to be somewhat erratic to treatment.

Working qualities.—Teak is a relatively easy wood to saw and work, and is popular in any workshop. It can be finished to a fair surface and takes polish well. It can be peeled on a rotary lathe and makes up into excellent plywood, both of the commercial and ornamental types. In Europe it is used in the form of sliced veneers for ornamental work. Such veneers are available now in India. It does not glue very well with casein cement.

Uses.—The uses of teak are too well-known and too numerous to describe here. It is the chief railway carriage and wagon wood of India, and is the most important furniture wood of the country. In ship-building it is in a class by itself. Its popularity is due to its relatively small coefficient of expansion and contraction, and to its durability. Burma and South Indian teaks are stronger than Central Provinces and Bombay teak, but the timber from these two latter Provinces is decidedly more handsome. Put briefly, teak from Burma and South India are preferable for constructional and utility purposes, while teak from the Deccan and the Dangs is preferable for beauty of grain and colour.

Sources of supply.—Apart from teak from Burma (the chief Indian markets for which are in Calcutta and Bombay) teak is obtainable in India from Madras, Bombay, the Central Provinces, Orissa, Bengal, Coorg and several Central Indian States. Enquiries should be addressed to the nearest Conservator of Forests of the above mentioned Provinces.

Prices.—Teak prices fluctuate considerably according to world demand, and the general trend of trade in India and other countries, in fact teak prices are a very good thermometer of world trade. The average for 1st class Indian squares is about Rs. 120 to Rs. 150 per ton.

Terminalia arjuna.

Trade name.—Arjun.

Vernacular name.—Vellamarutu (Mal.).

Weight.—.—About 47 to 50 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood pinkish white. Heartwood brown, marked and streaked with darker lines. No odour or taste. Irregular interlocked grain and coarse texture. A moderately heavy and fairly decorative wood, which could be used to effect for cabinet-making if timber was selected for the purpose. Otherwise, a useful utility and constructional wood.

Seasoning—A moderately refractory wood to season, somewhat liable to warping and splitting. Green conversion and careful stacking under weights (to prevent warping) and under cover in open piles, is the seasoning procedure recommended for this wood. It can be kiln dried without any difficulty or degrade.

Strength.—Arjun is 10 to 15 per cent. heavier than teak and 35 per cent harder. In shock resistance and shear it is 35 to 40 per cent stronger than teak, but in other strength functions it is 25 per cent below teak.

Durability.—The sapwood is very perishable and should not be used untreated. The heartwood is moderately durable, and some specimens in the "graveyard" tests at Dehra Dun were still in fairly good condition after 7 years. The heartwood can be treated but not very easily, penetration being complete in some cases and patchy in others.

Working qualities.—Not a very easy wood to saw and work, but it can, with a little care, be brought to a very fine finish. It turns well and takes a very good and lasting polish. Not tried for rotary cut veneers or plywood, but prohably more suited to sliced or sawn veneers. Selected stock can be very decorative and not unlike dark laurel *(T. tomentosa).*

Uses.—At present *arjun* is used locally for cart-building, agricultural implements, pit-props, water-troughs, boat-building and other domestic purposes. It does not appear to be used for furniture, whereas some very decorative wood could be found for this purpose with proper selection. Should also do well for picker arms and might possibly be suitable for shuttles.

Sources of supply.—Bihar, Orissa and the United Provinces all report supplies available. It is also found in South India (on the West Coast) where fair supplies can be obtained. Logs of

8 ft. girth are sometimes available, but 7 ft. or under is more common.

Enquiries should be addressed to the above mentioned Provinces.

Prices.—Orissa quotes Rs. 16 per ton and the United Provinces Rs. 15 per ton for logs (1937).

Terminalia belerica.

Trade name.—Bahera.

Vernacular names.—Bahera, thari (Coorg), *gothing.* Burmese name; *thitsein.*

Weight.—37 to 48 lbs. per c. ft. (air-dry).

Description of the wood.—A greyish yellow wood. No distinctive heartwood. Without odour or taste. Usually straight-grained and very coarse-textured. A timber of good strength but one which is very perishable and liable to attack from fungus and insects. If treated with a preservative, it would rank very much higher than it does at present.

Seasoning.—The timber seasons without difficulty or degrade, but it is liable to fungal stain if not dried quickly. Green conversion, followed by immediate stacking in open piles under cover, is recommended. It can be kiln seasoned quickly without difficulty, and comes out of the kiln in very good condition.

Strength.—Bahera, according to the strength tests done at Dehra Dun, is a much stronger wood than most people suppose. Due to its liability to insect attack and rot, which naturally weakens the wood, it has probably a worse reputation than it deserves. Except in the matter of retention of shape it is slightly stronger than teak in all strength functions. In weight and hardness it is 15 per cent above teak, and in shear it is 20 per cent above teak. In short, if the wood is sound it is a fairly strong wood in every way.

Durability.—As mentioned above, *bahera* is very liable to fungus and insect attack when in the green state. If seasoned, it is considerably more immune, and in the "graveyard" tests at Dehra Dun it lasted about 4½ years before being destroyed by white ants and fungus. It can be treated fairly readily with wood preservatives, the penetration being complete in some pieces and partial in others.

Working qualities.—An easy wood to saw and machine, but difficult to bring to a smooth surface, owing to its very coarse texure. It has been found quite amenable to rotary peeling, and makes up into good plywood of pleasing appearance. Recommended as definitely suitable for plywood work.

Uses.—In some districts, where better class and more durable woods are not available, *bahera* is in good demand, and is used for house-building purposes as rafters and boards, and for boxes and packing cases. If it was treated with a preservative it would be an extremely useful wood for many purposes, as it has good strength but fails in durability. Recommended for plywood work.

Sources of supply.—*Bahera* is a tree which is found scattered throughout the forests of Central, South, and East India. It is often obtainable in large girth logs of fair length. On the West Coast of Madras it is extracted in considerable quantities, and is one of the commonest commercial timbers found at West Coast ports.

Enquiries should be addressed to the nearest Conservator of Forests of Bombay, Madras, Assam, Bengal, the United Provinces and the Central Provinces.

Prices.—Bombay quotes Rs. 25 to Rs. 70 per ton for logs up to $4\frac{1}{2}$ ft. girth and 20 ft. length. Assam and Bengal quote from Rs. 20 to Rs. 40 per ton for logs and the United Provinces about Rs. 25 per ton (1937).

Terminalia bialata.

Trade names.—Silvergrey wood (false heartwood); white *chuglam* (sapwood).

Vernacular name.—*Chuglam.*

Weight.—43 lbs. per c. ft. (air-dry).

Description of the wood.—The outer (sapwood) portion is a creamy yellow toning to a greyish yellow on exposure. In a large proportion of logs there is a false heartwood of nut-brownor greyish brown colour with darker streaks and markings. This heartwood is known as Indian silvergrey wood. In some logs this false heartwood is fairly wide, in others it is small or even non-existent. Straight-grained. No odour or taste. Rather coarse texture. A useful and valuable medium-weight wood, much in demand for both decorative and utility purposes.

Seasoning.—If dried under mild conditions in a damp atmosphere, this wood is not difficult to season, nor does it develop bad seasoning faults. On the other hand, if it is dried down to a very low moisture content and is used in a very dry locality, it develops end-cracks and fine surface cracks which completely spoil the wood for cabinet and furniture work (silvergrey). Green conversion, followed by stacking under cover with a fair but not excessive air current through the pile, is the procedure recommended for seasoning this wood. It can be kiln-dried without any difficulty, as the conditions of drying can be regulated to suit the wood.

Strength.—White *chuglam*, except in the matter of retention of shape, is practically the same as teak in all strength functions. In weight and hardness it is identical with teak, and in all other strength functions it does not vary from teak by more than 5 to 10 per cent. In other words, it is a good strong medium-weight wood.

Durability.—Not a very durable wood. On the other hand, it is not extremely perishable. In the "graveyard" tests at Dehra Dun, the 6 specimens under test were destroyed by white ants and fungus in about $4\frac{1}{2}$ years. It will treat readily with preservatives, penetration being more or less complete.

Working qualities.—An easy wood to convert and work, either on machines or with hand tools, in fact it will stand up to high speed machining a good deal better than most woods. It can be finished to a fine smooth surface and will take a good polish. A wax polish suits it best. It has been tried for rotary cut veneers but it is not altogether satisfactory as, in very dry climates, the veneers develop fine hair cracks. It is more suited for the slicing

or sawing processes, and silvergrey has been used to superb effect in Europe as a decorative veneer for furniture and panelling.

Uses.—Silvergrey wood is one of the most handsome woods India possesses, and, if properly seasoned and used in the form of sliced veneers, or even in the solid, it is a most attractive and decorative wood. It can be used for all types of cabinet-making, and is especially fine for internal decorative work in ocean liners, railway saloons, modern stores and salesrooms, board-rooms and public halls. All the best squares find ready sale in England at high prices.

White *chuglam*, on the other hand, is not a decorative wood, but is a most useful utility timber for general joinery and carpentry work, ceiling or floor boards, motor car and bus bodies, upholstered or painted furniture, box shooks and railway carriage fittings. White *chuglam* is not corroded by bronze fittings, such as are used in shops. It would find ready sale in Europe but for its susceptibility to Lyctus attack. If means of reducing the starch content and so preventing this can be found, it will be a valuable wood. Its main use is as hide barrels. In moist climates it makes a good oar.

Source of supply.—Terminalia bialata is available only from the Andaman Islands, but it is procurable in large quantities in good size logs of long length or in sawn form. Enquiries should be addressed to the Chief Forest Officer, Port Blair, Andaman Islands.

Prices.—The current price of white *chuglam* scantlings is about Rs. 60 per ton. For first class logs containing a high percentage of silvergrey wood the price would be a good deal higher.

Terminalia myriocarpa.

Trade name.—*Hollock.*

Vernacular names.—*Panisaj, hollock.*

Weight.—39 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood light buff. Heartwood light brown or buff, somewhat streaked with darker coloured streaks. Turns duller with age. No odour or taste. Usually straight-grained and rather coarse-textured. A medium-weight utility wood which sometimes contains a wavy fiddle-back figure which could be used to advantage in cabinet making. Two varieties, known as white *hollock* and black *hollock*, are known to the trade, but the differences between the two have not been officially investigated.

Seasoning.—Unlike most of the *Terminalia* species, this wood is not difficult to season, and it usually dries out with little depreciation. Green conversion, followed by prompt stacking in open piles under cover, with good air circulation through the pile, is recommended for this species. It can be kiln-dried without difficulty.

Strength.—This wood is about the same weight as teak, but about 75 to 80 per cent. as strong and hard as teak.

Durability.—*Hollock* is not a durable wood. In the "graveyard" tests at Dehra Dun, all the specimens of "white" *hollock* under test were removed after about 3 years. In the case of "black" *hollock*, the 6 specimens under test were removed in five years. There appears, therefore, to be some difference in the durability of the 2 varieties. *Hollock* can be treated readily with wood preservatives, and penetration in the heartwood is more or less complete.

Working qualities.—A fairly easy wood to saw and work although sawyers say they do not like sawing it by hand when it is dry. It can be finished to a fairly good surface, but needs careful filling before it is polished. It is one of the two main woods used for plywood (tea-boxes) in the Assam plywood mills, and tests done at Dehra Dun confirm the fact that it makes up into good strong utility plywood. Possibly slicing on the quarter might produce an ornamental veneer of high value, as selected stock has frequently shown fiddle-back figuring on a quarter cut.

Uses.—Used in fairly large quantities locally for house-building, in the form of scantlings, beams, rafters, and planking. It also makes up into excellent furniture. Used in fairly large quantities by Assam plywood mills for tea-box work. If treated, makes a good railway sleeper and general constructional wood.

Sources of supply.—The main supply comes from Assam, but Bengal can also supply smaller quantities. Good logs up to 20 ft. length and 8 ft. girth are available. Enquiries should be addressed to the Forest Utilization Officer, Assam or Bengal.

Prices.—Assam quotes Rs. 45 per ton for logs and Rs. 1-6-0 per c. ft. for sawn squares of 18 inch siding. Bengal quotes Rs. 25 to Rs. 50 per ton for logs and Rs. 100 per ton for sawn material (1937).

Terminalia paniculata.

Trade name.—Kindal.

Vernacular names.—Kindal, pillamarudu (Mal.), *uluve* (Coorg).

Weight.—48 or 49 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood dirty white or grey. Heartwood greyish brown to brown. No taste or smell. Straight-grained and of medium texture. A fairly heavy non-ornamental utility wood of good strength. Popular in South India, where it is considered to be a very good wood. Further North it has not such a good reputation, the reason being that it is a refractory wood to season, and in the drier climates it gives trouble in this respect, whereas in the milder and damper atmosphere of the South West Coast it is far more amenable.

Seasoning.—Kindal is definitely a refractory wood to season, and if dried too quickly or under severe conditions develops surface cracks and splits. Under milder conditions it behaves far better. Green conversion, followed by careful stacking in a sheltered place under cover, to induce slow drying, is advocated as the best method of seasoning this wood. Kiln seasoning produces good results, and where possible it would be advisable to kiln season this wood in dry localities.

Strength.—Kindal is slightly heavier than teak and also 10 to 20 per cent. harder. In strength functions, a test consignment from Madras gave far better results than one from Bombay. The Madras material was 5 to 10 per cent. stronger than teak in most tests, while that from Bombay was 10 to 15 per cent. weaker than teak. Taken as a whole, *kindal* is a wood of good strength for its weight.

Durability—A wood of moderate durability. It has lasted for 5 to 10 years as an untreated sleeper. In the "graveyard" tests at Dehra Dun, it lasted 5 years before being destroyed by white ants. It can be treated only fairly-well with preservatives, the peneration being peripheral only and the absorption about 4 to 5 lbs. per c. ft.

Working qualities.—Not a very difficult timber to saw and work. The fiber is somewhat coarse and therefore, it does not machine as cleanly as some woods, but with a little care it can be brought to a fine smooth surface which takes a good polish. It was tested for rotary peeling, but was condemned as being very refractory to this process and unsuitable for plywood work.

Uses.—On the South West Coast, *kindal* is looked upon as an excellent constructional and general utility wood, and is fre-

quently used as a substitute for teak. The Railways use it for carriage and wagon work, and it is one of the most popular boat-building woods in the South. Further north it has a far less envible record and has a reputation as a bad splitter. The solution lies in the seasoning of the wood under mild conditions, and if *kindal* can be well seasoned to equilibrium with the surrounding atmosphere it makes an excellent constructional and building wood.

Sources of supply.—Supplies are available in large quantities from Bombay and in the South West of Madras. It can be obtained in long lengths and good girth sizes. Enquiries should be addressed to the Chief Conservator of Forests, Poona, Bombay or the Forest Utilization Officer, Chepauk, Madras.

Prices.—Bombay quotes Rs. 36 to Rs. 50 per ton for logs at forest dopots, and Madras quotes Rs. 20 to Rs. 30 per ton for logs at West Coast depots (1937).

Terminalia tomentosa.

Trade name.—Laurel.

Vernacular names.—*Asna, sain, asan, mutti* (Coorg), *sajar* (C. P.)., *karimarudu* (Tam)., *pucca saj* (Bengal), Burmese name: *taukkyan.*

Weight.—46 to 60 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood creamy-white. Heartwood varies considerably. Sometimes dull light brown, sometimes reddish brown, sometimes dark brown with good figuring or blackish streaks, and sometimes grey with blackish streaks. No characteristic smell or taste. Fairly straight-grained and of medium to coarse texture. One of the most widely distributed woods of India, and very common in many parts of the country. If it was less refractory in seasoning it would be one of India's most valuable woods, as it is a good strong, hard, and fairly durable wood capable of giving good service in constructional work, and at the same time it is capable of producing some of the most handsome figured wood in the world.

Seasoning.—Unfortunately this very common and widely distributed timber is very refractory to season, especially in large dimensions. If dried too quickly, or under adverse conditions, it develops surface cracks, splits and warps. The best procedure for drying the wood is to convert the logs green, preferably in damp or mild weather, and stack the converted material under cover and protect it from too rapid drying. If care is taken, and the surrounding atmosphere is mild, laurel will dry out successfully without much depreciation. It has been so dried at Dehra Dun, but it must be well protected against hot dry winds and sun. In kiln seasoning it can be dried with complete success and with practically no degrade, even in very wide planks.

Strength.—Laurel is about 25 to 30 per cent. heavier than teak, and in hardness it stands 50 to 60 per cent. higher than teak. In other strength functions it is usually within 5 to 10 per cent. of the teak figures, some laurel being stronger than teak while another consignment may be weaker. In shock resistance it is usually well above teak.

Described briefly, it is a good strong tough wood suitable for most constructional purposes.

Durability.—Laurel heartwood is well above the average in so far as durability is concerned. It will defy white ant attack and fungus for a number of years in favourable localities, but if conditions are unfavourable rot may set in fairly early. In the "graveyard" tests at Dehra Dun it lasted for about $7\frac{1}{2}$ years, and as a railway sleeper it usually lasts for 5 to 8 years, untreat-

ed. It can be treated readily with wood preservatives, the penetration in the heartwood being more or less complete and the absorption being from 8 to 9 lbs. per c. ft. under a pressure of 175 lbs. per square inch.

Working qualities.—With a wood varying so widely in weight, structure and general character, variations in the working qualities must be expected. Normal straight-grained stock is usually fairly easy to saw and work to a good finish. Hard cross-grained wood, on the other hand, is more difficult to saw and will probably need considerable hand finishing. It turns easily, and when brought to a smooth finish, takes an excellent polish. Not suitable for rotary cut veneers or plywood, but figured stock can be used to great advantage as sliced veneers. which, with proper selection and matching, can compare favourably with the finest figured walnut.

Uses.—Laurel is used almost universally throughout India for building purposes, as beams, joists, rafters and planking. Also used for carts, agricultural implements, posts, pit-props, piles, wagon floor boards in railway carriage construction, tool handles, electric casing, railway sleepers, and numerous other purposes. Selected figured stock is well known in Europe as a cabinet wood of exceptional beauty, and if used in the form of sliced veneers on laminated cores, it is hard to find a more handsome timber than figured laurel.

Sources of supply.—One of the most widely distributed and commonest trees of India. Any Province in India, except the Punjab, Assam and Sind, can produce good supplies. In size and quality it naturally varies within very wide limits. Enquiries should be addressed to the nearest Conservator of Forests. In most Provinces very large supplies are available. Arrangements are now made in some Provinces to supply selected figured logs or squares. Naturally the quality and extent of such figuring cannot be guaranteed, but a fair proportion of such selected logs usually contains figure of a kind.

Prices.—Prices for this wood range from Rs. 20 per ton to Rs. 250 per ton for selected figured logs. In most districts good laurel logs can, however, be bought for Rs. 30 to Rs. 50 per ton.

Tetrameles nudiflora.

Trade name.—Baing.

Vernacular names.—Bhelu (Ass.), *maina kat* (Beng.), *pontham cheeni* (Mal.), *perumara* (Coorg), *thitpok* (And.). Burmese name: *thitpok* or *baing.*

Weight.—22 lbs. per c. ft. (air-dry).

Description of the wood.—Pale yellowish-grey or cream colour, dulling on exposure to light buff. Heartwood not distinct. No taste or smell. Interlocked fibre in broad bands and coarse-textured. A very light, soft wood of the light box and crate wood variety.

Seasoning.—A wood liable to fungal stain, decay, and insect attack when green, but one which presents no difficulties in seasoning provided care is taken to prevent the above defects. Quick drying of the surface is necessary for this. The procedure recommended is green conversion, followed by a short period of vertical stacking in the open, after which the converted stock should be stacked in open piles under cover where there is a good circulation of fresh air. Kiln seasoning presents no difficulties.

Strength.—Baing is not a strong wood, and it should not be used where strength qualities are required. It is not unlike *semul* (*Bombax malabaricum*) in this respect, but is slightly harder. It holds nails well, however, and this makes it acceptable for box construction.

Durability.—Not a durable wood. It is very prone to fungal stain, insect attack and decay when green, but once it has been dried it remains sound under normal conditions, but should not be used in exposed locations unless it has been treated. It takes preservatives readily.

Working qualities.—A very easy wood to saw and work. It finishes to quite a good surface. It has been tested for rotary cut veneers and plywood, and passed as quite suitable for making up into cheap general purpose plywood for tea chests or other work. As a matter of fact, it has been used for plywood tea chests in Assam.

Uses.—Baing is already in fairly large demand in Assam and Madras for packing cases, tea chests, and box work generally. It is also used for ceiling boards and other domestic purposes. Very suitable for cheap utility plywood and also used in match factories for both boxes and splints, but it is brittle for the latter purpose.

Sources of supply.—Fairly common in Assam, Bengal, Madras and the Andamans, but being a useful light box wood, it has been considerably in demand, and supplies are not so plentiful as they were. The Andamans can produce 600 tons per annum, and Assam estimates the annual output at 2,000 tons. Enquiries should be addressed to the Forest Utilization Officers, Assam or Madras, or to the Chief Forest Officer, Port Blair, Andaman Islands.

Prices.—Assam quotes Rs. 30 per ton for logs and Rs. 1-0-0 per c. ft. for sawn squares up to 20 ft. in length and of 18″ sides (1937).

Trewia nudiflora.

Trade name.—Gutel.

Vernacular names.—Gutel, pitali (Beng.). Burmese name: *yem yok.*

Weight.—About 22 lbs. per c. ft. (air-dry).

Description of the wood.—A uniform creamy-white wood when first cut. Tones down to a pale buff on exposure. Frequently seen discoloured with grey fungal staining. Heartwood not distinct. No odour or taste. Usually straight-grained, with a medium fine texture. A very light useful wood of the packing case type.

Seasoning.—An easy wood to season. It does not split or warp, but it is very prone to fungal stain, decay and insect attack when green, and this makes it extremely difficult to obtain clean seasoned wood when conditions are not favourable to rapid drying. Kiln-seasoning immediately after conversion is the best procedure, and kiln-dried stock comes out in excellent condition. If kilns are not available, vertical stacking in the open immediately after conversion (in dry weather if possible) is the best method to adopt. When all surfaces of the converted stock are dry, the timber should be stacked under cover in open piles where there is a good circulation of fresh air.

Strength.—Gutel is not a strong wood and it should not be used where strength qualities are required. It is, however, denser than a wood like *semul* (*Bombax malabaricum*) and of its type a very useful wood.

Durability.—Not a durable wood, and one which is very liable to fungal stain and insect attack when green. It takes preservatives readily, and if required to last any length of time should be treated.

Working qualities.—A very easy wood to saw and work to a nice smooth surface Logs from good girth trees peel well on a rotary lathe and the veneers make up into good commercial plywood.

Uses—A typical packing case and box shook wood of good quality. The main drawback to its more extensive use is its liability to fungal staining and insect attack. If dried quickly in seasoning kilns, this objection disappears. It is used for match splints and boxes in several Provinces. As kiln-seasoning increases in India, this wood will probably find far more extensive markets than it does at present. A good plywood timber.

Sources of supply.—Available in good quantities and good sizes in the United Provinces, Bengal, and in more limited quan-

tities from Bombay and Assam. Enquiries should be addressed to the Forest Utilization Officers of the United Provinces, Bengal and Assam, or the Chief Conservator of Forests, Bombay.

Prices.—The United Provinces quotes from Rs 15 upwards per ton for logs. Bengal quotes Rs. 16 to Rs. 40 per ton and Bombay Rs. 50 per ton in log form (1937).

Vateria indica.

Trade name.—Vellapiney.

Vernacular names.—Dhupa, velthapaini (Coorg). Sometimes called "Malabar white pine".

Weight.—About 36 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood cream colour. Heartwood light yellowish buff, darkening to pinkish buff on exposure. No characteristic smell or taste. Interlocked grain in narrow bands and of medium texture. A good quality light wood suitable for many purposes.

Seasoning.—A wood which usually seasons fairly well. It is liable to the usual fungal staining and insect attack when green, but once it has been dried it is a very steady wood. Quick drying is necessary, and green conversion, followed by vertical stacking in the open for a few days is recommended. As soon as all surfaces are dry, careful stacking under cover with a good circulation of fresh air, should give good results. As some cupping and warping is sometimes experienced the stacks should be made carefully. Kiln seasoning presents no difficulties with this wood if care is taken, except that there is a considerable difference between the rate of drying of wood from the outer and the inner portions of a log. (Rehman).

Strength.—For its weight *vellapiney* is a moderately strong wood. It is usually about 15 per cent. lighter than teak, but in stiffness is equal to teak. In other strength functions it is below teak, and it ranks 40 per cent. below teak in hardness.

Durability.—Vellapiney is not a very durable wood, and if used in exposed positions, or where immunity from fungus and white ant attack are required for a long period, it should be treated. In the "graveyard" tests at Dehra Dun it only lasted for 2 years untreated. The heartwood does not treat very readily with preservatives, but some end penetration and a peripheral treated layer can be obtained under pressure.

Working qualities.—A nice wood to work. It saws and finishes to a good surface, but the bands of interlocked fibres sometimes necessitate some hand finishing. Takes a good polish. It has been tested for rotary cut veneers and plywood, and passed as suitable for this work. One expert plywood merchant in South India picked it out as giving a plywood very closely resembling gaboon plywood.

Uses.—Vellapiney is well known in South India, along the West Coast, as a most useful wood for tea boxes, packing cases,

interior work in houses, and planking generally. It is shipped to Bombay and Karachi under the name of "Malabar white pine" as a substitute for imported pine and "deal" woods. It is suitable for plywood work and has been used for match manufacture.

Sources of supply.—Supplies are confined to the South West of Madras, Coorg and Travancore, where it is in fair abundance. Good size cylindrical logs of great length are available. Enquiries should be addressed to the Forest Utilization Officer, Madras, or the Chief Forest Officer, Coorg.

Prices.—Madras quotes Rs. 26 to Rs. 31 per ton for logs, and Coorg quotes about the same (1937).

Xylia xylocarpa.

Trade name.—Irul.

Vernacular names.—Irul, surya (C. P.), *suria* (Bihar).

Weight.—52 to 59 lbs. per c. ft. (air-dry).

Description of the wood.—Sapwood pinkish-white, narrow. Heartwood reddish-brown to brown, darkening somewhat on exposure. No odour or taste. Irregularly interlocked fibres and medium to fine texture. A heavy and very hard wood of good quality. Very like the well-known Burmese *pyinkado* (*Xylia dolabriformis*), but usually slightly weaker.

Seasoning.—A difficult wood to season, and one which is very prone to surface-cracking, splitting, and warping, unless dried slowly under mild conditions. To obtain the best results, trees should be felled during or just after the rains, and the logs should be converted green. The converted material should then be carefully stacked under cover and well protected from hot dry winds and sun. Conversion should be avoided during hot dry weather, and if logs have to be kept they should be stored under water or protected in some way. Slow drying is the object to aim at. The wood can be kiln dried under a slow and mild drying schedule without any serious faults developing.

Strength.—Irul is a very hard tough wood. It is nearly twice as hard as teak and 55 per cent. stronger in shear. In other strength functions it is just above teak, and in weight it is 25 per cent. heavier than teak.

Durability.—A wood of natural durability well above the average. It lasts for about 8 to 10 years as an untreated sleeper under fair conditions. In the "graveyard" tests at Dehra Dun, out of the 6 specimens under test one was destroyed in 13 years, the rest remaining though badly attacked by white ants. The sapwood can be treated readily, but the heartwood is rather refractory to treatment, taking up only 1 to 2 lbs. of preservative per c. ft.

Working qualities.—Being a very hard wood, it is not very easy to saw, but it can, with care, be brought to a very smooth surface. Old trees frequently have unsound hearts, and it is always advisable to cut out the heart of *irul* during conversion, to prevent faults developing during seasoning. Sometimes some very decorative wavy-grained wood can be cut from selected stock.

Uses.—In South India, *irul* is a well known wood and one much used for railway sleepers, heavy constructional work, piles, pit-props, railway wagon floor boards, and general utility work.

If seasoned carefully it is a most valuable strong and durable wood. It was tried in Bombay for treated road blocks and proved excellent for the purpose. It would do excellently for wood block flooring of all descriptions. It can be used as a substitute for *Lignum vitae*.

Sources of supply.—This timber is available in large quantities from Madras, Bombay and Coorg, and in lesser quantities from the Central Provinces and Orissa. The South West Coast timber has a better reputation than that from further north.

Enquiries should be addressed to the Chief Conservator of Forests, Madras, Bombay or Central Provinces, the Conservator of Forests, Orissa, or the Chief Forest Officer, Coorg.

Prices.—Madras quotes Rs. 25 to Rs. 34 per ton and Bombay Rs. 32 to Rs. 50 per ton, for logs. The Central Provinces prices range from Rs. 50 to Rs. 75 per ton, and Orissa quotes Rs. 30 to Rs. 40 per ton (1937).

CHAPTER VI.

Woods recommended for various uses.

India possesses some 4,000 or more woody species amongst her luxuriant *flora*. There is, therefore, a wide choice of timbers for different purposes and in the past, more often than not, an unsuitable wood was selected because it happened to be common in the vicinity or because the user was not acquainted with the qualities required, or the characteristics of other species growing in the surrounding forests. To select the best wood for a definite purpose calls for an accurate knowledge of the qualities required, and reliable information as to the woods possesing those qualities. This knowledge is not acquired in a moment. The qualities concerned may refer to strength, seasoning, durability, workability on machines, steadiness in use, or a variety of other characteristics. These can be ascertained to a large extent by scientific research and tests, but the final answer is disclosed only after actual trial in practice. It was for the purpose of ascertaining the different characteristics and idiosyncrasies of the commercial timbers of India, that the Utilization Branch of the Forest Research Institute at Dehra Dun was brought into being. During the past 25 years or more, work on these lines has been steadily proceeding, and the accumulated knowledge on Indian woods is daily increasing. There is no end to such work, and with such a large number of woods in India to choose from, it is not always an easy matter to arrive at the best decision.

In the following pages, some recommendations and suggestions as to some of the best woods for specific purposes, have been recorded for the information of those interested. It is beyond the scope of this small book to recommend a wood for every purpose, but the examples given are fairly representative and they will, perhaps, be of help to some users as indicating the type of wood most suited to their special needs.

1. Aeroplanes and Gliders.

Roughly speaking timbers for aeroplane work may be divided into the following categories.

(a) Timber used for general constructional work such as spars etc.

(b) Timber for the high quality plywood used for covering purposes. The quality has to be especially high in the case of stressed parts.

(c) Timber used for propellor manufacture.

(d) Timber used for linings, or distance preces between two plywood skins.

(e) For targets and model aircraft.

(a) The usual timber used for spars etc. is *Sitka spruce*, a North American species. This species has been used because its strength/weight ratio is very high. Even in the magnificient spruce forests of North America, the percentage of yield of aircraft quality spruce is not high: there is, first of all, a careful selection of logs and then a selection of the sawn timber. The quality required is exceedingly high.

The obvious Indian substitutes are Indian spruce *(Picea morinda)* and Indian fir *(Abies pindrow)*. These have been tested in the Forest Research Institute, and have been found entirely satisfactory in strength properties. But these determinations are as small clear specimens. In actual fact these species are very knotty and it is still doubtful whether it will be found possible to produce clean timber of sufficient size to be of practical value: experiments in extraction are in progress. (1944)

Other possible alternatives are Andaman white *dhup (Canariam euphyllum)*. This timber is inferior in theoretical strength properties to spruce, but clean timber of great size will become available as soon as the Andamans are retaken. An advantage of this timber over spruce is that it is probably less prone to fungus attack than spruce, is far cleaner, and is far more easily exploitable.

Other possible substitutes are *champ (Michelia* spp.) and *bonsum (Phoebe goalparensis)*. Of these the first is about 3 lbs per cu. ft. heavier than sitka spruce and theoretically inferior to it, but it is a nice clean timber and may, in actual practice, be superior to it. *Bonsum* is a superior timber to spruce, but it is about 6 lbs per cu. ft. heavier: it is also very liable to crack if not seasoned carefully.

(b) Information regarding timber suitable for aircraft quality synthetic resin bonded plywood is not readily available. The species commonly used in Europe are birch and maple. Indian birch and maple will, therefore, be found suitable. Other Indian timbers which have passed the specification are :—

For stressed parts :—

Polyalthia fragrans

Zanthoxylum rhetsa

Dalbergia latifolia (rosewood)

Juglans regia (walnut)

For unstressed parts :—

Phoebe goalparensis (bonsum)

Dichopsis ellipticum (tali)
Dalbergia sissoo (sissoo)
Machilus macranthia (machilus)
Terminalia myriocarpa (*hollock*)
Mangifera indica
Michelia spp. (*champ*)
Chukrasia tabularis (*chickrassy*)
Himalayan maple
Dipterocarpus macrocarpus (*hollong*)

It is certain that several other Indian timbers will be found suitable, and experimental work is proceeding. (1944)

(c) In early days aircraft propellors were made by carving them out of a solid block of wood. For instance an Andaman *padauk* propellor, made in this way, was used on the aircraft which, once, held the altitude record. This method is bad because a large block of this sort is difficult to season and may contain hidden defects. The next stage was the laminated air screw. In this case boards are cut; after careful selection and seasoning, these are glued together into a block from which the propellor is carved. The commonest species used is mahogany. It is not clear whether timber of this quality is really necessary. Before the war, there was plenty of mahogany and it had a great reputation: cost is of no importance because this forms such a small percentage of the cost of the aircraft and life depends on the quality of the timber.

The best Indian timbers for the purpose are:—

Andaman *padauk (Pterocarpus dalbergioides)*
Aini (Artocarpus hirsuta)
Chickrassy (Chukrasia tabularis)
Champ. (Michelia champaca)
Bonsum (Phoebe goalparensis)

Other timbers such as *chaplash (Artocarpus chaplasha)* and *Acrocarpus fraxinifolius* may also be suitable. It is probable that, for manufacture in this country, the first necessity for timbers for laminated propellors is steadiness. The reason for this is that, however carefully the boards are seasoned, in glueing them into a block with casein cement, large quantities of water are put back into the block. In drying out, stresses will be set up and cracking may result during the manufacturing

process. Another point is that, although the blade is very carefully protected by efficient paints, the inside of the boss is likely to be exposed to direct air due to the paint wearing off, it will, therefore, be constantly absorbing and de-absorbing moisture; unless the timber is steady, cracking may result.

A variation of the propellor is the test fan. It is made in the same way as the laminated propellor. In Europe and America, birch is a popular timber but, due to its fairly poor retention of shape, it is probably not a good timber for use in India. *Padauk*, *aini* and *chikrassy* are probably the best Indian timbers to use. Test fans have a very hard life. Not only are they run for long hours, but because they are used to test propellors on a test bench, they are subjected to great heat from the engine, especially round the boss of the fan. Flight propellors are not, of course, subjected to this strain.

More advanced types of propellor are made wholly or purely of compregnated wood (laminated and compressed wood). This is outside the scope of this publication: it is enough to say that many Indian timbers have been tried for compregnated wood and found very satisfactory.

(d) The wood used for a lining or distance piece in certain aircraft is the famous balsa wood which comes from South America. It weighs only 8—12 lbs per cu. ft. At present we know of no Indian timber which can compete with it in weight. The following are suggested.

Timber	*Weight air dry*	*Province where obtainable.*
Cryptomeria japonica	about 16 lbs	Bengal
Erythrina suberosa	about 15 lbs	C.P. and U.P., Orissa.
Sterculia villosa	about 17 lbs	C. P., Bengal, U. P. Bombay, Punjab.

(e) For targets and model aircraft, the same species as mentioned under (d), with the addition of *Bombax malabaricum*, are suitable. Pith boards ($2\frac{1}{2}$ lbs per cu. ft.) and cork boards (5–7 lbs per cu. ft.) are also suitable.

II. Agricultural implements.

Agricultural implements is a term of rather wide application but it refers in the main to such appliances as ploughs, harrows,

rollers and clod-crushers. A strong, hard, tough timber is required for this type of work. *Babul (Acacia arabica)*, axlewood *(Anogeissus latifolia)*, *raj-brikh (Cassia fistula)*, satinwood *(Chloroxylon swietenia)*, *jaman (Eugenia jambolana)*, *sissoo (Dalbergia sissoo)*, *dhaman (Grewia tiliaefolia)*, *tendu (Diospyros melanoxylon)*, *sandan (Ougeinia dalbergioides)*, *mesua (Mesua ferrea)*, *Prosopis spicigera*, *Pterocarpus* species, *kusum (Schleichera trijuga)*, *sal (Shorea robusta)*, *irul (Xylia xylocarpa)* and *ber (Zizyphus jujuba)* are all used for agricultural implements of different kinds.

III, Axe helves and tool handles.

Woods for helves and tool handles must be strong and tough and must also possess great shock resisting abilities. Hickory and ash are the two best foreign timbers used for this purpose, and large quantities of helves and hammer handles made of these woods were being imported into India. As a result of tests conducted at the Forest Research Institute, however, it has been found that a number of Indian woods are as good as hickory, and superior or equal to ash as regards their strength properties; millions of helves and other types of handles made of these woods, have been supplied to H.M. Forces and the Railways since the out-break of the present war.

Many different types of handles are used in India. They can, however, be roughly classified as follows :—

Class I. *Handles for striking tools, heavy type.* These comprise all hammer handles of about 18 to 36 inches in length, for such purposes as heavy hand hammers, rivetting hammers, sledge hammers etc.

Class II. *Axe helves, heavy type.* These comprise large helves for $6\frac{1}{2}$ and $4\frac{1}{2}$ lbs. pick axes, felling axes, large mallets, beaters etc.

Class III. *Handles and helves for striking tools of light type.* These comprise small hammer handles of 10 to 16 inches in length and small axe helves, mallets etc.

Class IV. *Handles for scooping tools.* These include handles for earth working tools or agricultural tools.

Class V. *Handles for cutting and shaping tools.* These are required for carpenters tools such as planes, chisels, augers, saws, screw drivers, files, adzes etc.

Note.:—Class II has been shown separately from Class I because, in addition to toughness, it must possess great bending strength. Also the timber must work to a hard smooth surface without picking up fibres or splitting, because the hand of the worker has to slide backwards and forwards along these handles in the act of striking.

Class VI. Handles for such articles as brushes, brooms, maps, etc.

Class VII. Handles for a variety of miscellaneous small articles such as hair brushes, shaving brushes etc.

Toughness and strength are the chief considerations for selecting timbers for making handles of the first 4 classes, and also to a lesser extent for class V. For handles of classes VI and VII, several common and easily available timbers, working to a smooth surface, can be utilized as they do not require any special strength properties.

The following timbers have established themselves as first class hammer handle and helve timbers and have been included in the lists of approved timbers for H. M. Forces and the Railway Departments.

Anogeiesus pendula (*kardhai*), *Cynometra polyandra* (*ping*), *Ougeinia dalbergioides* (*sandan*), *Sageraea listeri* (*chooi*), *Celtis australis* (celtis), *Olea* spp. (*kao*), *Parrotia jacquemontiana* (*parrotia*), *Diospyros* spp. (light coloured wood of ebony, *tendu*). *Acacia arabica* (*babul*). *Grewia* spp. (*dhaman*), *Heritiera* spp. (*sundri*), *Kayea* spp., *Dalbergia* spp. (*sissoo*, rosewood), solid bamboos etc. etc.

Many other species are also being used during the war. *Anogeissus pendula* is an exceptionally strong and tough wood but is obtainable in small sizes only. Some timbers, such as *sundri*, are liable to develop fine cracks. Bamboo is very commonly used locally. As, however, its outer skin must not be removed in shaping, careful selection is necessary so that it may fit the hole of the tool properly without shaping.

For the handles of carpentry tools such as planes, chisels, screwdrivers etc. such woods as *Buxus sempervirens* (box). *Betula alnoides* (birch), *Acacia* spp. *Dalbergia sissoo* (*sissoo*), *Dalbergia latifolia* (rosewood), *Gmelina arborea* (*gamari*), *Pongamia glabra*, *Murraya exotica*, *Ougeinia dalbergioides* (*sandan*), and many others are used and found suitable.

Tool handles are often soaked in linseed oil, or shaken in a drum with paraffin wax to give them a smooth finish and good polish and a certain amount of resistance to moisture changes. The latter method is considered to be the best, more especially if pieces of hardwood are put in the drum to help the polishing.

IV. Battery separators.

Wood for battery separators should possess certain desired physical and chemical properties. It should be permeable,

straight-grained, sufficiently strong, easily worked and free from knots and other defects. Freedom from volatile acids, tannins and resinous matter and resistance to the action of the electrolyte are the chief requirements from the chemical standpoint. No Indian timber with the necessary physical qualities, so far examined, is absolutely free from the above mentioned chemicals.

In order to prevent the harmful action of these substances on the plates of the battery, they are eliminated by boiling the separators in 1 per cent caustic soda solution for two hours. The last traces of alkali are then removed by repeated washings before fitting them in the cells. Sometimes a short treatment in a glycerine bath helps in imparting extra flexibility to the washed separators which can be later stored without any danger of warping.

The experiments so far conducted have shown that the species which can be utilized for this purpose, after chemical treatment, in place of imported Port Orford Cedar (*Chamaecyparis lawsoniana*) in order of preference are : cypress (*Cupressus torulosa*), *champak* (*Michelia champaca*), *haldu* (*Adina cordifolia*) and *Talauma phellocarpa*. From the preliminary tests, it is concluded that, in addition to these four woods, some of the conifers viz., fir (*Abies pindrow*), spruce (*Picea morinda*), *kail* (*Pinus excelsa*) and *deodar* (*Cedrus deodara*) can also serve as substitutes for the manufacture of battery separators.

V. Bearings,

Lignum Vitae, a central American wood, is the timber most used for wooden bearings.

This wood is not available in India, but Andaman bullet wood (*Mimusops littoralis*) is a good substitute. It is the only Indian timber which passed the army tests with (a) oil and (b) soapsuds, the latter test being very severe. Other woods likely to be suitable for this purpose are *Soymida febrifuga*, *Hardwickia binata*, and *Mimusops elengi*.

Other woods tried in the army tests were rosewood, *sissoo*, *padauk*, *bijasal*, *kusum*, *gurjan*, *lendi* and boxwood, all of which failed to pass the test. Compregnated wood is under trial for this purpose.

VI. Bent-wood articles

Apart from sports goods, such as hockey sticks and tennis raquets, the steam bending of wood in India is not practised to any great extent. Mulberry and *Celtis australis* are the two woods most used in the Northern India sports goods factories, while *sissoo* is also used to some extent. All three timbers are excellent for steam bending. Rosewood, *gamari* (*Gmelina arborea*), *lendi*

(*Lagerstroemia parviflora*), *benteak*, (*Lagerstroemia lanceolata*) mango, *bijasal* (*Pterocarpus marsupium*), *toon* (*Cedrela toona*), *jhingan* (*Odina wodier*), *siris* (*Albizzia procera*), *Zanthoxylum rhetsa* and *Anogeissus pendula* (*kardahi*) are some other woods which are amenable to steam bending.

VII. Boat and ship-building

Country craft made entirely of wood play a very important part in the coastal and riverain trade of India, and various species are used in their construction.

Timber used in all small boats and larger ships is subjected to very great strains, and is often employed under circumstances which tax its durability to the utmost. For this reason any timber used for ship and boat-building should be strong, elastic, durable and free from defects.

TEAK is the best ship-building timber in the world, due to its relatively small co-efficient of expansion and contraction and to its durability. It is practically the only timber used by admiralties for naval work, and the best teak of Burma, known as "Admiralty" teak, is still exported to Great Britain for the use of the navy and other government marine departments.

European oak is also a good ship-building timber, but it contains tannic acid which corrodes iron. Teak also corrodes iron to a certain extent, and modern fastenings are nowadays generally made of yellow metal or galvanized iron which do not corrode.

In India, the timbers mentioned below are among the most common boat-building and shipwright woods.

(*a*) FOR THE HULLS OF BOATS (other than dugouts) the following timbers are used extensively:—

Acacia arabica	...	Much used in North and West India for all parts.
Acacia catechu	...	For keels and knees.
Artocarpus chaplasha	...	Used for all light boats in the Andamans. It is little bored by marine borers in the Andaman sea.
Artocarpus hirsuta	...	Much valued in South India for boat-building.
Calophyllum inophyllum	...	Commonly used in South India.
Dalbergia latifolia	...	Strong and good for knees.
Dalbergia sissoo	...	Largely used for knees and frames.
Dipterocarpus turbinatus		Commonly used in Chittagong and Burma.
Heritiera minor	...	The most used boat-building wood in East India.

Hopea species	...	Very strong and durable. *Hopea parviflora* is a favourite boat timber in Travancore.
Lagerstroemia hypoleuca	...	For hull planking.
Lagerstroemia lanceolata	...	One of the chief boat-building woods of South India.
Mangifera indica	...	Very good for side planking.
Pterocarpus dalbergioides		Strong and durable.
Sageraea elliptica	...	Excellent for ribs.
Shorea spp.	...	Very strong and durable.
Thespesia populnea	...	A favourite wood for ribs and knees.
Xylia species	...	Very hard and good for keels.

(*b*) For use as MASTS AND SPARS the timber must be long, straight, strong, elastic and not too heavy. The best examples are:—

Calophyllum tomentosum		The poonspar tree of South India.
Calophyllum inophyllum		An excellent spar wood.
Cedrus deodara	...	Commonly used in north India.
Casuarina equisetifolia	...	Used on the Bombay side.
Lagerstroemia lanceolata	...	Popular on the West Coast.

(*c*) Woods for OARS AND HELMS should be straight-grained, strong, elastic and light, and the following timbers have been found to be good for this purpose.

Casuarina equisetifolia	...	Used in districts where it is grown.
Cedrus deodara	...	A good light oar wood.
Celtis australis	...	A good oar wood.
Dipterocarpus sp.	...	A good oar wood.
Fraxinus floribunda	...	Used largely for oars in western countries.
Grewia sp.	...	Considered best by the ordnance department for strong oars.
Lagerstoremia parviflora		Makes good oars.
Morus spp.	...	Approved by the army authorities for light oars.
Pinus species	...	Used for the lighter types of oar, but not strong enough for heavy oars,
Podocarpus sp.	...	Proved very suitable for boat hooks.
Terminalia bialata	...	Good in moist climates.

(*d*) RAFTS AND LIFE SAVING APPARATUS—

The best wood for these purposes is balsa (*Ochroma* sp.), a very light tropical American wood. It weighs only 8-10 lbs. per c. ft. The supply is, however, limited, and *bakota* (*Endospermum malaccense*) from the Andamans makes a fair substitute. It is

this purpose. *Tatarameles nudiflora* (*baing*) is used in the Andamans for floats, and has been found better than *papita* (*Sterculia campanulata*) for this purpose, as it remains afloat for a long time while *papita* becomes waterlogged.

See also the suggestions made for model air craft.

(*e*) DUGOUTS—

The following woods are amongst those used for dugouts in different parts of India :—

Bombax malabaricum (good if kept submerged when not in use), *Duabanga sonneratioides*, *Gmelina arborea*. *Mangifera indica*, *Tetrameles nudiflora* and *Trewia nudiflora* (good in salt water). *Artocarpus chaplasha* is said to be the best wood in the Andamans for dugouts.

VIII. Bobbins.

Many Indian woods have been tried for bobbin manufacture to replace imported birch and beech but the only wood which has found an extensive use for the purpose is *haldu* (*Adina cordifolia*). It is a suitable wood for most types of bobbin if properly seasoned, but it is slightly more brittle than beech. There are, of course, numerous articles classed under the general term "bobbins". These include such objects as slubbing tubes, skewers, rover tubes, pirns of various kinds, and reels for cotton and other textile yarns. Some of the Indian woods in addition to the *haldu* now being used for bobbins of various kinds, are *kaim* (*Mitragyna parvifolia*), *kuthan* or *baurang* (*Hymenodictyon excelsum*) *Holoptelea integrifolia*) and *keaora* (*Sonneratia apetala*). Pear-wood is also used for handmade pirns and reels in Amritsar.

Other species considered suitable for different types of bobbins are *dudhi* (*Wrightia tinctoria* and *W. tomentosa*), *hoom* (*Saccopetalum tomentosum*), *kura* (*Holarrhena antidysenterica*), *jhingan* (*Lannea grandis*), mulberry (*Morus alba and M. indica*), *kadam* (*Anthocephalus cadamba*), birch (*Betula cylindrostachys*), *Amoora* species, *gamari* (*Gmelina arborea*), *chickrassy* (*Chukrasia tabularis*), *Zanthoxylum* species, satinwood (*Chloroxylon swietenia*), *banati* (*Lophopetalum wightianum*) and Indian poplar *Populus euphratica*). *Mallotus philippinensis*, *Morinda tinctoria*, *Gardenia lucida* and *Pongamia glabra* are also suggested for cotton reels. *Salai* (*Boswellia serrata*) is also worth trying as this wood is available in very large quantities and at a fairly low price. Many of the smaller types of imported bobbins are made from branch wood or from young poles, and, in order to be able to compete with the imported articles, it should be possible to find suitable woods among species which grow to a small size only, or the branch wood and young pole stock of the more valuable species.

IX. Boot lasts and shoe heels.

There is a considerable demand in India for foot and shoe lasts, and recently the demand for shoe heels, and especially ladies' shoe heels, has grown enormously,

For BOOT AND SHOE LASTS, a tough wood which is not too hard is required. In addition, the wood must be able to stand repeated nailing. This last quality is not common and there are not many woods which can stand up to the repeated nailing required for a boot or shoe last. *Sissoo* (*Dalbergia sissoo*), *jhingan* (*Lannea grandis*), *Gardenia* species, *ber* (*Zizyphus jujuba*), *Polyalthia cerasoides*, *kaim* (*Mitragyna parvifolia*), *gamari* (*Gmelina arborea*), *Ehretia laevis*, *jarul* (*Lagerstroemia flos-reginae*) and *Acer* spp. are considered suitable for this purpose. *Sisso* is the most popular wood for boot and shoe lasts in North India, and considered to be the best last wood by the army boot factories in Cawnpore. Maple and bird cheery are considered to be the next best.

For SHOE HEELS, mango has been found very satisfactory. Other timbers suggested are *kaim* (*Mitragyna parvifolia*), *kanju* (*Holoptelea integrifolia*), *Gardenia* species, *nimi chambeli* (*Millingtonia hortensis*) and *Kydia calycina*. *Haldu* is used, but it is not ideal as it is liable to crack and chip off during nailing, and is rather brittle for tall heels. Other species which might be tried for shoe heels are *Wrightia* species, Indian poplar (*Populus euphratica*), *Holarrhena antidysenterica*, *salai* (*Boswellia serrata*) and *jhingan* (*Lannea grandis*).

Boxes. See page 216.

X. Brushes.

The term brushes comprises a very large variety of articles, ranging from ornamental hair brushes, through numerous types of utility brooms, horse brushes and scrubbing brushes down to the simple shaving brush used in such large quantities.

For ornamental hair-brush backs, such woods as ebony (*Diospyros ebenum* and *Diospyros melanoxylon*), satinwood (*Chloroxylon swietenia*), rosewood (*Dalbergia latifolia*), *sissoo* (*Dalbergia sissoo*), Andaman *padauk* (*Pterocarpus dalbergioides*) and *chickrassy* (*Chukrasia tabularis*) are used. For cheaper utility types of toilet brushes, such timbers as *haldu* (*Adina cordifolia*), *toon* (*Cedrela toona*) mango (*Mangifera indica*) and *kuthan* (*Hymenodictyon excelsum*) are used. For general utility brushes, *nimi chambeli* (*Millingtonia hortensis*) has been found superior to all other Indian woods. It works easily and well, retains its clean colour, and gives no trouble in seasoning. The next best species for general utility work are *kuthan* (*Hymenodictyon*

excelsum), mango, *kaim* (*Mitragyna parvifolia*) and *kanju* (*Holoptelea integrifolia*). For shaving brush handles, *kaim* is said to be the best.

Cabinet making. See page 210.

XI, Cart and carriage building.

The various parts of a cart or carriage are subjected to different kinds of stresses and strains, and require different qualities of wood for real efficiency. In actual practice, however, the most suitable and easily available local wood is used for country cart-making, irrespective of whether it is really suitable for the various parts of the vehicle.

The main parts of a cart are the framework, the hub, the axle, the wheels and the shafts or pole.

For the FRAMEWORK, the following woods are examples of the type of wood most suitable for the purpose; *Ougeinia dalbergioides*, *Dalbergia sissoo*, *Dipterocarpus* species, *Dysoxylum malabaricum*, *Eugenia jambolana*, *Lagerstroemia* species and *Terminalia bialata*, all of which are moderately strong but not too heavy.

The HUB of a wheel has to bear great strain and must be hard and tough. Some woods commonly used are *Ougeinia dalbergioides*, *Acacia arabica*, *Acacia catechu*, *Hardwickia binata*, *Shorea robusta*, *Mesua ferrea*, *Schleichera trijuga*, *Chloroxylou swietenia*, *Hopea parviflora* and *Heritiera minor*. The same woods with, the notable addition of *Anogiessus latifolia*, are more often than not used for the AXLES also.

Wood for SPOKES must be straight-grained, strong and elastic. The best are *Dalbergia sissoo*, *Dalbergia latifolia*, *Grewia tiliæfolia* and *Pterocarpus marsupium*. Other woods such as *Acacia arabica*, *Heritiera minor*, *Anogeissus latifolia* and *Shorea robusta*, *Diospyros* species and *Hardwickia binata* are also frequently used.

FELLOES are subjected to much crushing and alternations of wetting and drying, and must be hard, strong, elastic and durable. Naturally curved or bent timber is better for felloes than that artificially shaped. Sal, babul, and other plentiful woods are very commonly used in the United Provinces and other Provinces for country carts, but the best woods for the purpose are *Acacia arabica*, *Dalbergia sissoo*, *Dalbergia latifolia*, *Pterocarpus marsupium* and *Grewia tiliæfolia*.

SHAFTS are usually made of split wood, but in carts intended solely for the transport of goods the shafts are often made of

solid timber in the round. Wood for shafts should be tough, elastic, straight-grained and very strong. The best woods are *Grewia* species, *Anogeissus* species and similar very strong woods. *Thespesia populnea* (*bhendi*) and *Cassia glanea* (*son-tarwad*) are used in Bombay for shafts where available. The latter is often planted in gardens for the purpose. Bamboo is also very extensively used for making shafts and is admirably suited if properly selected. Sal is very frequently used for shafts, but it is not altogether an ideal wood for the purpose. Many other timbers, including *Artocarpus hirsuta* (aini), *Bridelia retusa*, *Hopea* species, *Lagerstræmia* species, *Terminalia* species, *Albizzia* species and *Cedrus deodara*, are frequently used for cart and carriage building in those parts of India where they are common.

Carving. See p. 227.

XII. Construction and general joinery work.

Constructional woods are those timbers used for superstructures, which includes all parts of houses and buildings, bridges and similar structures not actually in contact with water or the earth.

The demand for this type of work is naturally very large in India, where the timber utilized in superstructures exceeds that of all other industries both in quantity and value.

For the superstructures of permanent buildings a timber should be strong and durable. If it is not naturally durable, it should be properly treated with a suitable preservative. Lightness is sometimes an asset if strength and durability are not sacrificed. Floor and wall planking should be non-warping and non-shrinking, and the wood for interior work and panels should be ornamental.

Timbers answering to these specifications are numerous in India, but there are three woods which stand out above all others as building timbers, due chiefly to their being available in very large quantities. These are teak, *sal* and *deodar*.

Teak and *sal* are very strong timbers, *deodar* is also a fairly strong timber, and what is more important in India, where the white ant is so plentiful, they are durable timbers. In addition to these three, the following list, though representing only a few of the woods actually used for building purposes in India, comprises some of the most commonly used structural timbers of India:—

Abies pindrow (Himalayan silver fir).—Weight 33 lb. per c. ft. (air-dry). The wood is white and soft, and has no distinctive smell. It is easy to work and finishes smoothly. It usually has

a fair number of knots, but it is an excellent and useful light wood of the 'deal' variety which can be employed with satisfaction for all internal work. It is not, however, a durable timber and should be treated with a preservative if required for external use or where liable to be attacked by fungi or insects.

Acacia arabica (*babul*).—Weight about 52 lb. per c. ft. (airdry). A very hard and fairly durable wood. Excellent for house posts, and for such purposes as flooring, where hardness is an asset. Can be ranked amongst the best of India's naturally durable hardwoods, where its special features are required.

Adina cordifolia (haldu).—Weight 40 lb. per c. ft. (air-dry). A fine close-grained wood for internal fitments. For such purposes as bathroom, bakery, dairy, and kitchen fitments, it could not be bettered. It is a clean, pale yellow wood of fine texture and can be easily cleaned by washing and scrubbing. It is only moderately strong and is inclined to be brittle when cross-grained and should not be used for external work as it is not very durable.

Albizzia lebbek (*kokko*).—Weight 41 lb. per c. ft. A fairly strong and durable wood, which can be used with advantage for most structural purposes. Selected timber can also be very handsome, and for flooring, panelling, and heavy furniture it has a proved worth above the average.

Albizzia odoratissima (black *siris*).—Very similar to *kokko* but slightly heavier and harder. Weight about 55 lb. per c. ft.

Albizzia procera (white *siris*).—Similar in appearance to the other two *Albizzias* but not so heavy. It is, however, stronger than *kokko* and deserves more recognition than it has had.

Artocarpus species (*chaplash*, *aini*, *jack* and *lakooch*).—Weights vary between 34 abd 40 lb. per c. ft. (air-dry). Good medium-weight woods of proved utility. *Chaplash* is suitable for interior and ornamental work. *Aini* has the reputation of being the best substitute in India for teak. It is a very durable wood and very easy to season. It does not warp or crack and equals teak in strength while being slightly lighter in weight. Jack also is a sound wood and, when available, can be used with confidence for interior work of all descriptions. *Lakooch* is the heaviest of the quartet, but is also the most durable and is much prized for house posts, rafters, and beams, as being highly resistant to termites and other insects.

Bischofia javanica (bishop wood).—Weight 35-48 lb. per c. ft. (air-dry). A useful structural wood for general utility proposes. Somewhat weak, easily worked but durable, especially in contact with water.

Calophyllum species (*poon*).—Weights from 41 to 48 lb. per c. ft. (air-dry). The outstanding feature of these woods is the size and length of the logs obtainable. They are already well-known as superb mast and spar woods, and are worth the notice of engineers and others who may require timbers of great length, combined with strength and elasticity. They should, however, be treated with preservatives if used in exposed positions as they are subject to attack by insects and fungi.

Cedrela toona (*toon*).—Weight 30 lb. per c. ft. air-dry. Probably the most universally used 'bazaar' wood in India, owing to its wide distribution and extensive cultivation as a shade tree. Being cheap, light, easy to work and quickly seasoned, it lends itself for use in small workshops, and although not very strong or durable, it is an excellent wood for backings, linings, panels, doors, cupboards, and similar work.

Cedrus deodara (*deodar*).—Weight 35 lb. per c. ft. (air-dry). One of the three general utility woods of paramount importance in India. Extremely easy to season, saw, and work to a clean finish. Extremely steady and durable and one of the few timbers which resists termites. Has a strong aromatic smell and oozes resin from the knots even after seasoning. It is not, therefore, a good wood for interior fittings and should not be used for painted or polished work, but is a timber of outstanding merit for all other structural and building work.

Chukrasia tabularis (*chickrassy*).—Weight 42 lb. per c. ft. (air-dry). An excellent medium to light weight wood for internal fittings. Often very handsomely figured and never gives trouble after seasoning.

Dalbergia latifolia (Indian rosewood).—Weight 55 lb. per c. ft. (air-dry). One of the finest cabinet woods that India possesses. Very strong and easy to work. Too good and expensive a wood for house members and ordinary work but excellent for interior fittings and furniture.

Dalbergia sissoo (*sissoo*).—Weight 50 lb. per c. ft. A well-known furniture and general utility wood in North India. It is strong, elastic and reasonbly durable. Can be used for all structural work with confidence, and selected wood makes exceptionally handsome fitments and panelling.

Dipterocarpus species (*gurjun*, *kanyin*, *eng*, hollong, etc.).—Weight 45 to 53 lb. per c. ft. (air dry). The timbers in this group are all typical constructional and general utility timbers. *Eng* is the heaviest and strongest, but the gurjuns are also good strong woods, not very durable but well-suited for building purposes, for roofing and for flooring, especially if treated. Prices are usually very moderate.

Duabanga sonneratioides (*lampati*).—Weight 28 lb. per c. ft. (air-dry). An excellent timber for all general proposes. Deserves to be better known, but supplies are limited. Does not warp or split or 'move' badly after manufacture.

Hardwickia species (*piney* and *anjan*),—Piney, weight 43 lb. and anjan, 46-67 lb. per c. ft. (air-dry). Two excellent general utility woods, and most suitable for beams, rafters. and house posts. *Anjan* is very heavy and hard, but it is also very durable and tough.

Heritiera minor (*sundri*).—Weight 65 lb. per c. ft. (air-dry). A heavy and extremely strong, tough and durable wood, which can be used with advantage for heavy constructional work, house posts, and such like work.

Hopea species (*hopea*, Andaman *thingan*).—Weighs from 39-73 lb. per c. ft. (air-dry). Excellent general utility woods. Strong, tough and naturally durable and eminently suitable for all structural work.

Lager stroemia species (*jarul*, *benteak*, Andaman *pyinma*,etc).—Weighs usually between 40 and 50 lb. per c. ft. (air-dry). Another family of useful utility woods. Straight-grained, strong elastic timbers of more than average merit.

Mangifera indica (mango).—Weight 42 lb. per c. ft. (air-dry) A useful cheap constructional wood. Moderately soft, strong, easy to work, but not very durable unless treated.

Mesua ferrea (*mesua*).—Weight 54-75 (average 60) lb. per c. ft. (air-dry) for Assam timber, and 67 lb. per c. ft. for South Indian timber. An extremely hard, strong, and naturally durable wood for all kinds of heavy constructional work.

Ougeinia dalbergioides (*sandan*).—Weight 55 lb. per c. ft. (air-dry). A very sound tough and elastic wood which deserves every attention.

Picea morinda (*spruce*).—Weight 29 lb. per c. ft. (air-dry). An excellent substitute for 'deal'. Not naturally durable, but comparatively strong and very suitable for internal work.

Pinus longifolia (*chir*),—Weight about 35 lb. per c. ft (air-dry). A well-known pine wood which, next to *deodar*, is used more than any other wood in North India. Is not durable, but can be treated easily. An excellent all-round cheap 'deal' timber for internal fittings, matchboarding and similar work.

Pinus excelsa (blue pine).—Weight 32 lb. per c. ft. (air-dry). A slightly superior wood to *chir*, and eminently suited for all

types of work for which European and American 'deal' woods are used.

Pterocarpus species (Andaman and Burma *padauk*, *bijasal*, etc.).—Weighs between 45 and 54 lb. per c. ft. (air-dry). This family comprises some of India's most valuable woods. They are all very steady, strong, durable, and handsome woods and are unsurpassed for high class constructional or ornamental work.

Shorea species (*sal*, *thitya*, *makai*).—Weights vary from 37 lb. per c. ft. for *makai* (*Shorea assamica*), to 65 lb. per c. ft. for *thitya* (*Shorea obtusa*). *Sal* (*Shorea robusta*) is about 50 to 56 lb. per c. ft. (air-dry), and is probably the best-known and most used wood in Central and East India. It is naturally durable, and the heartwood resists termites for many years. *Thitya* is harder and heavier than *sal* and just as durable. *Makai* is a much lighter timber and more suitable for interior work.

Tectona grandis (teak).—Weight 38 to 43 lb. per c. ft. (air-dry). Burma and Malabar teak is usually fairly straight-grained and of even texture and colour. Central Indian teak is often well-marked with dark streaks and veining, and although more handsome, is weaker than teak from Burma and Malabar. They are all equally durable.

Terminala species (laurel, *kindal*, white *chuglam*, *badam*, *hollock*, etc.).—Weighs vary between 39 lb. per c. ft. for *hollock* and *badam* and 53 lb. per c. ft. for laurel. The *Terminalia* family comprises several common and useful woods, most of which make excellent structural timbers. Their chief defect is a tendency to crack and split, but their availability will always ensure their continued use in the districts where they are found.

Xylia species (*pyinkado* and *irul*).—Weighs 57 and 52 lb. per c. ft. (air-dry) respectively. *Pyinkado* is the Burma species and *irul* the South India species. Both are excellent hardwoods for general utility work. *Pyinkado* is naturally very durable, and *irul* only slightly less so. They are both extremely strong tough woods, but are on the hard side for sawing and working unless green.

Bridges.

Timbers for bridge construction must be *very strong and durable*, being subjected to great strains when heavy traffic passes over the bridge, and exposed to all kinds of weather. If the bridge surface is also wooden, the timber used must be *hard* and *able to stand up to continual wear aud tear.*

The strongest and most durable timbers weight for weight in the above list are :—

	Weight (Teak—100).	Strength as a beam (Teak—100).	Stiffness as a beam (Teak—100).
Acacia arabica	120	115	90
Cedrus deodara	80	75	75
Dalbergia species	120	90	85
Dipterocarpus species	105	105	110
Hopea odorata	105	105	95
Mesua ferrea	135	140	145
Pterocarpus species	115	120	105
Shorea species	130	125	130
Terminalia tomentosa	120	100	100
Xylia dolabriformis	130	130	130

The percentage figures given above should not be taken as exact in cases where a number of species are included in one family, as for example in the case of *Dipterocarpus* species in which there are a large number of species of varying weights and strengths. The figures given are an average for all species tested in the family.

The hardest and most suitable timbers for **bridge floorings** include the following :—

	Hardness (Teak—100).
Acacia arabica	180
Albizzia species	115
Hopea species	160
Mesua ferrea	185
Pterocarpus macrocarpus	200
Shorea species	180
Terminalia tomentosa	130
Xylia species	180

Other superstructures.

For other superstructural work such as derricks, scaffoldings, jetties, etc., all the timbers mentioned under 'Bridges' are excellent where great strength and durability are required, while most of those mentioned under 'Buildings' are also suitable except where durability is lacking (if durability is required).

Non-durability can, however, be remedied by treating the timber with a good preservative. It is preferable to treat and use timber in the round for such purposes, as round timber is stronger than squared timber and sapwood is more easy to treat than heartwood.

XIII. Cooperage.

Cooperage or barrel-making consists of two types, "tight cooperage", *i. e.*, barrels used for liquids, and "loose or slack cooperage" used for dry goods like cement.

The oaks (*Quercus dilatata* and *Quercus semecarpifolia*), *dhaman* (*Grewia tiliaefolia* and *Grewia vestita*), and *sandan* (*Ougeinia dalbergioides*) have been found suitable for tight cooperage, for beer and liquor casks. *Semul*, *gamari* (*Gmelina arborea*) and *baing* (*Tetrameles nudiflora*) are good for oil casks. For slack cooperage, mango, spruce, *salai*, *kuthan*, *Odina wodier*, *Saccopetalum tomentosum*, *semul*, and *baing* have all been used. *Salai* has been found to be good for cement barrels and is used for wire nail kegs in Tatanagar (Bihar). Black *siris* has been used for cement barrels in Madras and the Central Provinces, and *Sterculia urens* and *Mitragyna parvifolia (kaim)* have also been used for this purpose.

Spruce is used for rosin casks at Jallo and has been proved excellent for the purpose. Fir has also been used with success. Mango is used at Clutterbuckganj for the same purpose.

Dysoxylum malabaricum (white cedar) is used for oil casks and vats on the West Coast, and *Artocarpus hirsuta (aini)* and *Lagerstroemia lanceolata* are other good tight cooperage woods. Teak is used in Burma as the best cask wood for liquors, where the odour of the wood is not objectionable.

Deodar and *sal* are used for liquor storage vats, and *kail* and teak are used for fermentation vats. Cypress is also a good timber for vat making.

Teak is an excellent wood for dyeing vats in cotton mills, and has been reported on as better than the woods used in imported vats. Mango casks are used fairly extensively for the transportation of molasses.

The approved army list of Indian woods for tight (wet) cooperage comprises the following timbers:—*Salai*, *gamari*, *siris*, mango, *jaman*, *kaim*, *aini*, *benteak*, *lendi*, *kuthan*, *jarul*, *moru* oak, teak, *sandan* and *dhaman*.

XIV. Electric transmission poles.

The qualities necessary to make a good pole are that it should be straight, *i.e.*, without crooks and bends, that it should not

split or crack excessively, and that it should have the required strength for the work it has to do. As electric transmission poles are usually of round timber in its natural state, that is to say with the sapwood intact or only slightly trimmed, proper preservative treatment is essential. It is preferable, therefore, to use, whenever possible, a wood that absorbs preservative readily and one in which complete penetration is possible. A pole of durable heartwood from which the sapwood has been trimmed, *e.g.*, sal, can be used, but generally speaking a properly and efficiently treated pole is preferable to an untreated pole. Insufficient treatment is highly dangerous and usually results in the early failure of the poles from decay or termite attack. All cracks are inlets to the interior of the pole, and unless there is a large core of durable heartwood, or the whole pole is properly impregnated throughout with preservative, failure usually occurs within a very short time.

The woods so far used in India or suggested for use as electrical transmission poles are :—

Pinus longifolia (chir).—One of the straightest and best poles so far found in India. Unfortunately, difficulties of extraction make its extensive use improbable. Must be well treated throughout.

Shorea robusta (*sal*).—Reasonably straight poles for country lines are readily obtainable. A good, strong pole. Sapwood very perishable and must be completely treated. Mature heartwood poles can be used untreated if all sapwood is trimmed off.

Poeciloneuron indicum.—A good straight pole used in South India. Rather liable to excessive cracking. Must be treated throughout.

Hopea parviflora.—A good strong pole.

Pinus insignis.—A good straight pine pole available only from the Kodaikanal plantations, Madras. Must be treated throughout.

Tectona grandis (teak).—Good straight teak poles are available in some parts of India. As they are mostly of sapwood, they must be well treated with a preservative.

Heritiera spp. (*sundri*).—Available in Bengal but not in very long lengths.

Casuarina equisetifoia.—Good straight poles are available from some of the coastal plantations in Bombay, Madras and Orissa, A strong wood, but one which is reputed to be very liable to split badly. Must be treated.

Bruguiera gymnorhiza.—A mangrove species, found in the Andamans and Sunderbans. Strong and obtainable in good lengths. Must be treated.

Other species which might be suitable for the purpose include *Terminalia tomontosa* (*laurel*), *Calophyllum* species (*poon*), *Lagerstroemia lanceolata* (*benteak*), *Polyalthia simiarum*, *Cleistanthus collinus*, *Lagerstroemia parviflora* (*lendi*), *Anogeissus latifolia* (axlewood), *Mesua ferrea* (*nahor*), *Cedrus deodara* (deodar), *Pinus excelsa* (*kail* and possibly palmyra palm, if obtainable in suitable sizes. The last named has approximately the same strength as sal and treats readily. It is not durable untreated. Deodar is already used extensively in Kashmir for electric transmission and telegraph lines.

XV. Engraving and printing blocks.

Up till a few years ago, imported boxwood and birch were the most popular woods for calico printing blocks. Efforts were made to find Indian substitutes for these timbers, and binga (*Mitragyna diversifolia*), *kaim* (*Mitragyna parvifolia*) and *chooi* (*Sageraea elliptica*) were tested and found to be very suitable for the purpose. Sandalwood (*Santalum album*) is also a very good wood for engraving work. Other substitutes are *Gardenia* species, *Randia dumetorum* and *Olea ferruginea*, while for some classes of work *Wrightia tinctoria*, *Holarrhena antidysenterica* and *Canthium didymum* would be very suitable. *Babul* (*Acacia arabica*) is also the type of wood which would do for this kind of work, and it is, as a matter of fact, already being used successfully for the carved discs used for stamping coloured patterns on cloth.

Sissoo in North India, and rosewood in South India, are the most popular woods for calico printing blocks. *Sissoo* is considered to be excellent for the purpose. *Toon* and teak are also sometimes used. *Tamarindus indica* is also said to be good for printing by the Indian method.

XVI. Floor blocks (parquet).

Wood block flooring is of two kinds, the ornamental house floors known as "parquet" and the utility type of wood block floors used in factories and storehouses.

For the former, an ornamental wood is desirable. In addition, hardness and retention of shape are important. The best Indian woods for the purpose are teak and Andaman *padauk*. Burma *padauk* is possibly the best parquet floor wood in the world on account of its steadiness and hardness. A Burma *padauk* parquet floor at Dehra Dun is in a perfect state after 15 years. Teak and Andaman *padauk* are just as good as Burma *padauk* except that

the latter is harder. Other good woods for parquet floors are *irul* (*Xylia xylocarpa*), *babul* (*Acacia arabica*), *gurjan* (*Dipterocarpus* species), black *siris* (*Albizzia odoratissima*), *chickrassy* (*Chukrasia tabularis*), *sissoo* (*Dalbergia sissoo*), *anjan* (*Hardwickia binata*), *jarul* (*Lagerstroemia flos-reginae*), and laurel (*Terminalia tomentosa*) if well seasoned.

For utility floor blocks any reasonably hard tough timber will serve. If there is likelihood of white ant attack the blocks should be well treated with a good preservative. Floors of the utility type are usually laid with the cross-grain of the wood uppermost. This gives a better wearing surface than when blocks are laid with the side grain uppermost. In addition to the hardwoods, treated *chir* pine and treated blue pine (*kail*) make excellent utility floor blocks.

XVII. Furniture, cabinet making and panelling.

For high class furniture, cabinet-making and decorative panel work, there are several very ornamental and excellent woods in India. The chief characteristics required for these uses are non-liability to crack and split, retention of shape, ease of working, and good colour, figure and grain. The following timbers are amongst those most commonly used and recommended for the purpose :—

Albizzia species (*kokko*, *siris*, etc.).—Good steady brown woods with a golden sheen.

Betula alnoides (Indian birch).—An excellent cabinet wood.

Cedrela toona (*toon*).—A light weight reddish wood, commonly used for furniture and carved work.

Chukrasia tabularis (*chikrassy*).—A light brown wood, often highly figured.

Chloroxylon swietenia (satin wood).

Dalbergia latifolia (rosewood).—One of India's best furniture woods.

Dalbergia sissoo (*sissoo*).—An excellent rich brown furniture wood. Excellent for veneered work and carving.

Juglans regia (walnut).—A well known furniture wood in common use in Kashmir. A good carving wood.

Phoebe species (*bonsum*).—Light weight furniture woods. Usually very steady.

Pterocarpus dalbergioides (Andaman *padauk*).—A well-known steady red-coloured cabinet wood.

Pterocarpus marsupium.—A popular furniture wood in South India.

Swietenia macrophylla (mahogany).—A well known and very steady cabinet wood, but only limited supplies available from Madras and planted trees elsewhere.

Tectona grandis (teak).—Central Indian and Bombay teak often have a very handsome grain figure. Burma and South Indian teaks are usually not so ornamental.

Terminalia bialata (silvergrey).—A handsome light-coloured wood with greyish markings. Apt to develop surface cracks in dry hot localities.

Terminalia tomentosa (laurel).—Dark-coloured figured laurel is undoubtedly one of India's most handsome cabinet woods, but it requires careful and thorough seasoning.

For the cheaper types of utility furniture made in India, many timbers are used. Amongst the most common the following may be mentioned :—

Chir pine, *kail*, deodar, spruce, fir, cypress, *haldu*, *jack*, *chaplash*, *aini*, mulberry, *vellapiney*, *poon*, *gurjan*, *jarul*, mango, *nim*, *dhup*, white *chuglam*, *gamari*, white cedar (*disoxylon malbaricum*), *Hardwickia binata* and horse chestnut.

For CAMP FURNITURE for which strength and lightness are required, the following are suitable :—

Zanthoxylum rhetsa.—Camp beds and chairs.

Dysoxylum malabaricum.—Considered best wood in Madras.

Atalantia monophylla.

Morus species (mulberry).—The best wood for camp beds and chairs.

Betula alnoides (birch).

Lagerstroemia hypoleuca.

Albizzia procera.—Camp beds and chairs.

Cupressus torulosa (cypress).—Tables, washstands, etc.

Phoebe species *(bonsum)*,—Tables, washstands, etc.

Imported camp furniture is usually made of ash or birch. There are very few Indian woods (if any) which have the same shock resisting qualities as ash for an equivalent weight. Mulberry is probably the best Indian substitute, but even this wood falls below ash in shock resistance.

The approved army list of woods accepted for military camp furniture comprises the following timbers :—ash, mulberry,

dhaman, axlewood, *yon*, *sissoo*, rosewood, *bijasal* and Andaman *padauk*.

Gliders. See p. 189.

Gun stocks. See p. 222

Handles. See p. 193.

Helves. See p. 193.

Hulls. See p. 196.

Joinery work. See p. 201.

XVIII. Jute mill rollers.

The imported jute mill rollers are made of plane tree. The timber is cut into 9" x 9" scantlings which are throughly air seasoned for about three or four years. The seasoned scantlings are then cross cut into $1\frac{1}{2}$" thick sections from which the rollers are manufactured.

Several Indian timbers have recently been tested for jute mill rollers. Since it was difficult to air season the thick scantlings for a long time, green logs of various species were cross cut into $1\frac{1}{2}$" thick discs which were air dried, well protected from sun and hot winds. In most cases the discs cracked during seasoning. However it was found practicable to prevent the cracking of discs by giving them a saw-cut along one radius immediately after conversion. This cut opened out in the form of V in drying, preventing several other cracks along the periphery. From each large disc seasoned in this way two or three half wroughts for jute mill rollers were obtained. This method was particularly helpful in case of *Kuthan*, mango, *keora* and *salai*. *Kuthan* (*Hymenodictyon excelsum*), mango (*Mangifera indica*), *keora* (*Sonneratia apetala*) and *hollock* (*Terminalia myriocarpa*) are considered suitable for jute mill rollers.

XIX. Marine piles and harbour work.

For this work, resistance to the teredo and other marine organisms is the most important quality, but so far no Indian wood, nor, as a matter of fact, any wood in any country, has been found to be completely immune against marine borers in all waters. Teak, *pyinkado*, and Andaman *pyinma* (*Lagerstroemia hypoleuca*) are resistant for a time in some waters, but even these woods cannot hold out for long againt the persistent attacks of the teredo in certain harbours. Greenheart at one time had the reputation of being immune to teredo attack in India because it had lasted well in some foreign waters, but this idea has now been exploded. It is no more immune than some Indian woods, neither are the Australian timbers jarrah and karri. *Artocarpus gomeziana* has the reputation of being immune to teredo attack in the Andamans but it is not known how it will prosper in other waters.

Treatment with creosote prolongs the life of marine structures for some years. Pressure treatment is the best, but an open tank treatment is not without value, provided the end and side penetration is at least $\frac{3}{4}$" to 1". A brush treatment is of little value. Wood pressure-treated with fairly high concentrations of Ascu wood preservative has also done extremely well in most Indian harbours, and so far as the experiments in this direction have gone, the indications are that wood well treated with Ascu will resist the ravages of teredo for a good number of years, and is superior for this purpose to wood treated with creosote. Two engineers in charge of Indian ports have expressed the opinion that Ascu treated wood appears to be the most satisfactory material so far found for use in the ports in question.

Masts. See p. 197.

XX. Match splints and boxes.

Practically the whole of the Indian demand for matches is met by match factories in India. But, as India does not possess easily available timbers which are suitable for making first class match splints comparable with European aspen splints, many factories, especially those near sea ports, use imported timber for their best quality splints and Indian woods for the boxes and lower grade splints. A good match wood for splint manufacture must be soft, straight-grained, white and cheap. It must also be capable of absorbing paraffin and must not glow after burning. Unfortunately the majority of the cheaper Indian white woods have interlocked grain and crooked or spiral growth. *Siderexoxylon longepetiolatum* (*lamba pathi*) is, however, almost as good as aspen for splints. It is one of the finest species for match box manufacture in the world. *Endospermum malaccense* (*bakota*), after bleaching, makes, a good splint. Some hold that, if adequate quantities of these two timbers were available, aspen would be kept off the Indian market to a considerable extent.

India possesses many woods which are suitable for box making and low quality splints.

Canerium euphyllum (white *dhup*) is a good box wood and the entire quantity available from the Andamans (12,000 tons) is used for this.

Bombax malabaricum (*semul*) is used universally in India, but is much inferior to white *dhup*. It is also used for splints, but semul splints are of rather a poor quality.

The following are some of the chief species used in India for splint manufacture, but they make, at best, only second quality splints. *Anthocephalus cadamba* (*kadam*), *Canarium* species (*dhup*), *Endospermum malaccense* (*bakota*), *Hymenodictyon excelsum* (*kuthan*), *Sterculia campanulata* (*papita*), *Swintonia*

floribunda (*civit*), *Trewia nudiflora* (*gutel*), *Vateria indica* (*vellapiney*), *Tetrameles nndiflora* (*maina*), *Evodia roxburghiana* (known as Malabar aspen), *Populus nigra* (poplar) and *Salix* (willow) species in Kashmir, *Symplocos* species, *Ailanthus* species, *Spondias mangifera*, *Excaecaria agallocha* (*geon* or *gengwa*) and *Alstonia scholaris*.

For further information on this subject readers should refer to the "List of Indian Woods Tested for Match Manufacture", published by the Forest Research Institute, Dehra Dun.

XXI. Mathematical instruments.

The better class of mathematical instruments such as set-squares, rulers, etc., are usually made of boxwood, walnut (*Juglans regia*) and horse chestnut (*Aesculus indica*), but cheaper instruments intended for school use are often seen made of *haldu*, *toon*, *dudhi* (*Holarrhena antidysenterica*), gardenia, *kanju* and *prunus* species and other local woods. Fir and spruce are largely used in the Punjab for cheaper varieties of foot rules. *Mullilam* (*Zanthoxylum rhetsa*) and *haldu* are used for the same purpose on the Malabar coast. *Kail* and cypress make good drawing boards and plane tables. *Gamari* (*Gmelina arborea*), *kuthan* (*Hymenodictyon excelsum*) and *nimichambeli* (*Millingtonia hortensis*) are also good for this type of work.

Other woods suggested for different types of mathematical instruments and rulers are *Calophyllum tomentosum*, *Wrightia tinctoria*, mango and *kaim* (*Mitragyna parvifolia*). Boxwood (*Buxus sempervirens*) is, of course, the finest wood for the purpose but it is difficult and costly to extract. As substitutes for boxwood may be mentioned, *Atalantia monophylla*, *Gardenia latifolia*, *Randia dumetorum* and *Parrotia jacquemontiana*.

For set-square and ruler edgings, good quality hardwoods such as rosewood, *sissoo*, and ebony are most frequently used.

XXII. Mine work and pit props.

For mine frameworks and pit props good durability is a very necessary requirement, but one which is only too frequently ignored. Strength is also a necessary factor, and in the case of pit props compression parallel to the grain is of importance, to enable the timber to stand up to the enormous pressure exerted by the weight of earth it supports. Timbers commonly used are *Shorea robusta* (*sal*), *Heritiera minor* (*sundri*), *Terminalia tomentosa* (laurel), *Diospyros melanoxylon* (*tendu*), *Hopea parviflora* (*irubogam*), *Anogeissus latifolia* (axlewood), *Acacia arabica* (*babul*), *Grewia tiliæfolia* (*dhaman*), *Terminalia arjuna* (*arjun*), *Xylia xylocarpa* (*irul*) and *Gmelina arborea* (*gamari*). Many

other timbers are suitable, but, if used in the round or inclusive of sapwood, preservative treatment should be insisted on.

Model air craft. See p. 192

XXIII Motor lorry and bus bodies.

The demand for wood for motor lorry and motor bus bodies has been on the increase in India for some years now. There is a specially large demand for military lorry bodies, and the following timbers have been approved by the army authorities for mechanically propelled vehicles :—

Floor and side planks.

Deodar, cypress, *kail*, *chir*, teak (Burma and Malabar), *poon*, *chaplash*, *aini*, *gamari*, white cedar, white *bombway* and Andaman *pyinma*.

Runners, bolsters and windscreen frames.

Sissoo, rosewood, Burma *padauk*, Andaman *padauk*, *bijasal*, teak (Burma and Malabar), *sal*, *benteak*, *thingan*, *aini* and *dhaman*.

Hoopsticks for hoods and tilt covers.

Mulberry, *dhaman*, *sissoo*, rosewood, teak, *benteak*, *bijasal*, Barma *padauk*, Andaman *padauk* and Andaman *pyinma*.

There are, of course, many other Indian woods which are suitable for lorry body building, but the above lists are fairly representative and comprehensive. It is very necessary to use well-seasoned wood for all motor lorry and bus bodies. Apart from wear and tear, especially round bolt and screw holes, there is danger from rot at all joints and bolt holes where water is inclined to lodge. Painting such places with 2 coats of hot creosote or a preservative of the *Solignum* or *Creosant* type helps considerably in reducing such hazards.

XXIV Musical instruments.

For sounding boards and bodies of stringed instruments a regular and even structure is required. In Western countries the timbers used are usually evengrown conifers. In India, many woods are used for making such instruments as tom-toms, *sitars*, violins, etc., teak. *toon*, *sissoo*, mulberry, *gamari* and *haldu* being amongst the commonest. *Carapa moluccensis* has been found to be good for gramophone and wireless cabinets. Oak and teak are used for organ bodies, and spruce and *kail* for reed

boards and sound boards. For violins, spruce, *kail* and *chir* pine are used for the bodies, maple for the bridges, teak, rose wood and ebony for the keys, and rosewood and *sundri* for the bows.

For *sitars*, teak is used for the long neck, and deodar or *sissoo* for the keys. *Toon* is almost universally used for the bodies.

For *banjos*, teak is most commonly used.

For *drums*, Indian ash, mulberry, *sissoo*, *bijasal* and *siris* are used.

Canarium euphyllum (While *dhup*) has been used with success for guitars.

Oars. See p. 197.

XXV. Packing cases and boxes.

Woods for these purposes must be light, easily worked and cheap. They must have good nail-holding power and should, preferably, be of whitish colour. For general purposes there is a fairly wide choice of species; but for special boxes such as those for packing tea, butter and other foodstuffs, the wood should be free from any objectionable odour, which might taint the contents of the box, and for this reason timbers like teak, deodar, etc., are of no value.

Tea is now generally packed in plywood chests, which are strong, light and cheap. *Hollock* and *hollong* are used for making good plywood tea-chests. *Semul* is being used extensively at present but the tea-chest made of *Semul* plywood of standard 3/16" thickness is very weak. Attempts are being made at the F.R.I. to increase the strength of *semul* plywood tea-chests so as to make it suitable for export trade. Rough packing cases are often made out of the large dealwood cases received from Europe. Dealwood is also imported in fairly large quantities. The following are some of the commonest Indian woods used for packing cases and boxes: —*semul*, mango, *toon*, *chaplash*, *salai*, *kanju*, *champ*, *dhup*, *gutel*, *kuthan (Hymenodicton excelsum)*, *kadam*, *lampati* (*Duabanga sonneratioides*), civit (*Swintonia floribunda*), *gokul* (*Ailanthas grandis*), *maina* (*Tetrameles nudiflora*), *Polyalthia fragrans*, *Lophopetalum wightianum*, *vellapiney* (*Vateria indica*), *Alstonia scholaris*, white cedar (*Dysoxylum malabaricum*), *Kydia calycina*, *Elaeocarpus* species, *Terminalia chebula*, *Spondias mangifera* *Sterculia* species, and the conifers: spruce, fir, *chir* and *kail*.

The Andamans are rich in useful box woods such as *dhup*, *lambapatti*, white *chuglam*, *didu*, *papita* and *parishia*, but most of these are in good demand for match manufacture.

Cigar boxes are made in south India of *Cedrela toona*, *Melia azedarach* and *Melia composita*.

Terminalia chebula is a popular wood in South India for coffee boxes, while popular (*Populus* sp.) is much sought after in North India for fruit crates and grape boxes. *Swintonia floribunda* (civit) is used by the Burma Oil Coy. for kerosine oil cases and is considered very satisfactory. *Lagerstroemia parviflora* (*lendi*) and *Terminalia belerica* are also considered good where a strong box is required.

Panneling. See p. 210

XXVI, Pencils and pen-holders.

Pencils.—Efforts have been made on several occasions to find a really first class pencil wood in India. So far, the only woods which have proved to be of the right quality for this work are the Indian junipers (*Juniperus macropoda* and *Juniperus recurva*). Other woods are used in India for pencil making, but the quality of the pencils is not up to that of pencils made of true American pencil cedar (*Juniperus virginiana*), or the African pencil cedar (*Juniperus procera*) the wood mostly used in India for good quality pencils.

Amongst the timbers used in India for pencil making may be mentioned cypress, blue pine or *kail*, *kuthan* (*Hymenodictyon excelsum*), *semul*, *toon*, *Kydia calycina*, *Salix tetrasperma*, *Melia composita*, *Carapa obovata*, *Bischofia javanica*, *Mastixii arborea*, *Elaeocarpus tuberculatus* and *Holigarna arnottiana*. The last 3 are used in Madras for pencil making, and are reported to be very good for the purpose. *Carapa obovata* is used by a large Calcutta pencil factory and they find it quite satisfactory but somewhat hard.

Pen-holders.—Penholders do not require any special quality of wood, other than an even fine texture and straight grain. All the woods mentioned above for pencils are suitable, while other timbers such as *haldu*, *gardenia*, *gamari*, *kaim*, *Holarrhena* and *Wrightia* species are known to make good pen-holders. Spruce and fir are also used in North India for cheap pen-holders.

XXVII. Picker arms.

Picker arms used in Indian textile mills are mostly made of imported hickory, but there is no reason why Indian woods should not be used for this purpose. *Benteak*, *lendi*, mulberry, *sandan*,

dhaman, *sundri* and axle-wood have all been tried commercially and found suitable for this purpose. Other timbers considered suitable are *babul*, *hoom* (*Saccopetalum tomentosum*), laurel, *ber* (*Zizyphus jujuba*), *Bauhinia retusa*, *Hopea parviflora*, *Mesua ferrea* and the white wood of *tendu* (*Diospyros melanoxylon* and *D. tomentosa*). *Sundri* (mentioned above) has been reported on as suitable but distinctly on the heavy side. Axle-wood is said to give very good service but is also rather heavy and extra power is required to overcome the initial load.

XXVIII. Picture framing.

No very special qualities are required for picture framing, so long as the wood used is well seasoned and not liable to warp. There are two distinct types of picture framing, one in which the wood is used in its natural state, either polished or waxed, and the other in which the framing is painted or covered with a plaster composition which is moulded to the form required and covered with gilt or other colouring mediums.

For the former type of framing any steady ornamental wood is suitable, the most commonly used being teak, *sissoo*, rosewood, ebony, *bijasal* and *haldu*. The latter stained black, makes an excellent subsitute for ebony.

For cheaper frames, in plain moulded form or painted, light conifer woods such as fir and spruce are the best. Amongst the hardwoods, timbers like *kuthan*, *gutel*, *salai*, *semul* and *maina* are very suitable for this type of work.

School slate-frames can be made from a variety of woods. Amongst those commonly seen are *Trewia nudiflora* (*gutel*), *Tetrameles nudiflora* (*maina*), *Polyalthia fragrans*, *Dysoxylum malabaricum*, *Terminalia chebula*, *Kydia calycina*, *Alstonia scholaris*, *Ailanthus* species, *Mangifera indica* (mango), *Zanthoxylum* spp., spruce and fir.

For moulded picture framing, almost any well seasoned light-weight wood is suitable. Such woods as *semul*, *kuthan* (*Hymenodictyon excelsum*), *Kydia calycina*, *Ailanthus* species, *Sterculia urens* and *Erythrina* species could be used. Spruce and fir are also excellent for the purpose. It is however very necessary to season such woods well before the moulding medium is applied, otherwise the moisture in the wood may prevent a good and permanent bond between the wood and the moulding material. Composition-covered (moulded) picture framing is not made as yet on any extensive scale in India, but it is an industry which might well be expanded in this country as the demand is fairly extensive and steady.

Pit props. See p. 214

XXIX. Plywood and laminboards.

Plywood.—A number of Indian woods have been tried and found commercially suitable for plywood.

Amongst those actually being used by commercial plywood factories in India are *semul*, rosewood, *sissoo*, mango, *hollong*, *hollock*, *toon*, *piney* (*Vateria indica*), white cedar *Dysoxylum malabaricum*), teak, *Zanthoxylum rhetsa*, *pali* (*Dichopsis* sp.) *strombosia* spp, *Evodia roxburgiana*. *Polyalthia* spp. and *sterculia alata*.

The following additional timbers have been tested at Dehra Dun and also found suitable for the purpose :—

Acer campbellii.
Adina cordifolia.
Alnus nepalensis.
Amoora canarana.
Artocarpus chaplasha.
Artocarpus hirsuta.
Betula alnoides.
Bucklandia populnea.
Canarium strictum.
Canarium euphyllum.
Chukrasia tabularis.
Cullenia excelsa.
Dipterocarpus alatus.
Duabanga sonneratioides.
Eugenia jambolana.
Gmelina arborea.
Lophopetalum wightianum.
Machilus macrantha.
Michelia champaca.
Pollaquium ellipticum.
Phoebe hainesiana.
Pterospermum acerifolium.
Shorea assamica.
Swietenia mahagoni.
Swintonia floribunda.
Tectona grandis.
Terminalia belerica.
Tetrameles nudiflora.
Trewia nudiflora.
Veteria indica.

There are now at least 11 firms manufacturing plywood in India. The two oldest are in Assam and are fully occupied manufacturing tea box plywood. The most up-to-date plywood factory is at Sitapur in the United Provinces

This factory has a slicing machine as well as peeling lathes, and as its machinery comprises a hot press it is in a position to make air craft and naval plywood bonded with synthetic resin glues. The only other pre-war factory is that at Kallai, near Calicut, on the west Coast.

Of the more recent plywood factories erected in India, two are in Madras, 2 in Bengal, 2 in the Punjab and 1 in Travancore State.

Before leaving this subject of plywood, it should be noted that the chief difficulty in the establishment of plywood factories in India has been the lack of sustained supplies of suitable woods within an economic radius and in sufficient quantities to maintain

a modern plywood factory. The minimum requirements are in the neighbourhood of 4,000 tons per annum and prospective manufacturers would be well advised to explore this timber supply question before launching out on any plywood scheme.

Laminboards.—Laminboards are usually made up with cheap inferior woods for the cores, and better quality decorative wood for the faces. Such timbers as *chir-pine*, spruce, fir, *semul*, *gokul* (*Ailanthus grandis*), *maina* (*Tetrameles nudiflora*), *and Kydia calycina* are very suitable for core work, while better class timbers such as teak, rosewood, Andaman *padauk*, *sissoo*, *chickrassy* and *toon* make excellent face veneers. Face veneers are usually sliced, and there are two firms in India now slicing veneers of Indian woods, one in Calcutta and the other at Sitapur in the United Provinces. The latter firm also has a complete up-to-date plant for manufacturing laminboards. There are other firms in India also manufacturing laminboards with hand presses, and now that sliced veneers are available in India, this industry should progress rapidly.

In conclusion, it may be mentioned that plywood machinery is now made in India by Messrs. The Standard Machinery Coy., 86B Clive Street, Calcutta. Also by Rays Machinery Co.

Propellers. See p. 191.

Rafts. See p. 197

XXX. Railway carriage and wagon building.

The qualities required of a wood to be used in railway carriage and wagon work are that it should be sufficiently strong and durable for the purpose in view, that it should be free from bad seasoning defects, and that it should be available in sufficient quantities to ensure a continuous supply of at least 500 tons per annum.

Teak complies with this specification better than any other timber, and for this reason teak is the main timber used by all the railway wagon and carriage works in India. When the price of teak has been high, the Indian railways have sought for substitutes, and several other Indian woods are actually used for different purposes, but the mainstay of the wagon and carriage shops is teak. Amongst other timbers used by the Indian railways, the following may be mentioned.

Shorea robusta.—For wagon repairs and floor boards. Not very satisfactory as too prone to warping.

Pterocarpus dalbergioides.—Panelling in saloons and casing boards.

Adina cordifolia.—Used for seats and casing boards.

Cedrus deodara.—Used for shutters and wagon boards.

Dalbergia latifolia.—Furniture, repairs and flooring.

Acacia arabica.—Bolster beams, pillars, framing and floor boards.

The following woods are also used in fair quantities for miscellaneous work.

Cedrela toona, *Dipterocarpus* spp., *Lagerstroemia* spp., *Pinus longifolia* and *Pinus excelsa*, *Pterocarpus marsupium*, *Terminalia tomentosa* and *Xylia* spp.

Some of the Indian woods suggested for trial for various purposes are as follows :—

PILLARS, RAILS, CROSS-BARS.—*Pterocarpus dalbergioides*, *Pterocarpus macrocarpus*, and *Pterocarpus marsupium*, *Albizzia lebbek*, *Lagerstroemia hypoleuca*, *Lagerstroemia flos-reginae*, *Dipterocarpus pilosus*, *Grewia tiliaefolia*, *Anogeissus acuminata* and *Shorea assamica.*

FLOOR BOARDS.—*Dipterocarpus tuberculatus*, *Dipterocarpus pilosus*, *Hopea odorata*, *Hopea parviflora* and *Terminalia tomentosa.*

ROOF AND CEILING BOARDS.—*Lagerstroemia hypoleuca*, *Terminalia procera*, *Phoebe hainesiana*, *Lagerstroemia lanceolata*, *Hopea odorata*, *Hopea parviflora*, *Gmelina arborea*, *Adina cordifolia* and *Calophyllum* species.

PARTITION BOARDS.—*Lagerstroemia hypoleuca*, *Pinus excelsa*, *Pinus longifolia*, *Phoebe hainesiana*, *Cedrus deodara*, *Dipterocarpus tuberculatus*, *Hopea odorata*, *Hopea parviflora*, *Legerstroemia flos-reginae*, *Terminalia tomentosa*, *Shorea assamica*, *Lagerstroemia lanceolata*, *Terminalia bialata* and *Calophyllum* species.

PANELLING AND DECORATIVE WORK.—*Gmelina arborea*, *Adina cordifolia*, *Albizzia lebbek*, *Terminalia tomentosa*, *Pterocarpus dalbergioides* and *Pterocarpus macrocarpus*, *Dalbergia* species, *Terminalia bialata* (silvergrey), *Pentace burmanica* and *Chukrasia tabularis.*

DOORS AND WINDOWS.—*Lagerstroemia hypoleuca*, *Acacia arabica*, *Gmelina arborea*, *Lagerstroemia flos-reginae*, *Pterocarpus dalbergioides*, *Dalbergia latifolia*, *Dalbergia sissoo* and *Chukrasia tabularis.*

XXXI. Railway keys and brake blocks.

For railway keys and brake blocks a very hard tough timber is required.

Such timbers as *babul* (*Acacia arabica*), *cutch* (*Acacia catechu*), *anjan* (*Hardwickia binata*), bullet wood (*Mimusops* species), *irul* (*Xylia xylocarpa*), *mesua* (*Mesua ferrea*), *tendu* (*Diospyros melanoxylon*), *bael* (*Aegle marmelos*), *sundri* (*Heritiera minor*) and *hopea* (*Hopea glabra* and *Hopea parviflora*) are all very suitable for these purposes.

XXXII. Railway sleepers.

The replacement of wooden sleepers in India amount to about 4,000,000 sleepers a year. The untreated woods most commonly used at present are *sal*, deodar, teak, *pyinkado*, *mesua*, *irul* and *bijasal*.

As regards treated sleepers, chir pine, *kail* or blue pine, spruce, fir, *hollock*, *hollong*, *ping*, *jaman*, *jutili*, laurel, *kindal* and a few other species are all in use. Treating plants are on the increase, especially in South India, and other species will no doubt be introduced if supplies are available. *Gurjan* has been tested and well reported on.

The life of sleepers varies considerably in different railways and with different conditions. The life of *sal* and *pyinkado* is usually reckoned to be about 16 to 18 years, that of deodar 12 to 14 years, and of other untreated hardwoods 10 to 12 years or even less in some districts.

The life of treated sleepers in India varies with conditions between about 12 and 18 years.

XXXIII. Rifle parts and gun stocks.

Walnut (*Juglans* species) is the chief timber used for the manufacture of rifle wood work all over the world, as it stands up exceptionally well when worked to a fine finish on high speed cutting and drilling machines. The wood is also very steady and is not prone to excessive shrinking, swelling, warping or splitting, once it is properly seasoned. India was dependent for a number of years on imported walnut for rifle work, and it was only during the Great War (1914-18) that the question of using Indian walnut was taken up. Though Kashmir walnut is a bit lighter in weight and also somewhat weaker than European and American walnut, it has now been accepted for several years as the approved timber for rifle work.

Hitherto, supplies of walnut for the Indian rifle factory were drawn from Kashmir. but on account of the increased demand supplies from other areas also are now being accepted. This

wood grows in the Western Himalayas, extending as far eastward as Darjeeling, but the timber is difficult to extract except in Kashmir, and in the N. W. F. P., Kulu, Seraj, Bushahr, Tehri-Garhwal and Simla Hill States. The "laying out" and cutting of rifle half-wroughts require considerable skill and experience, as the specifications and passing of half wroughts are very strict.

The seasoning of the half-wroughts is also important. It is usually done partially near the area of supply and completed later in the seasoning kilns and conditioning sheds at the Ishapore rifle factory.

Various trials have been carried out at different times to find other Indian woods suitables for rifle half-wroughts, but so far none has been found to replace, walnut except maple (*Acer pictum*) and bird cherry (*Prunus padus*). The timbers that have been tried and condemned are *aini*, *bijasal*, *haldu*, *kanju*, teak, *kokko*, horse chestnut, *pussur*, *Hardwickia pinnata* and *Xanthoxylum rhetsa*. Further trials in this connection are in progress.

XXXIV. Road paving blocks.

Wooden paving blocks considerably reduce traffic noise and can be usefully employed for paving roads in shopping areas in cities and opposite hospitals, etc. where noise is objectionable. Woods for this purpose should be durable, resistant to wear and tear, fairly hard, not liable to absorb water and of even texture. Blocks may vary in size, but they are best laid with the cross section uppermost and, except in the case of very durable species, are nearly always treated. *Xylia dolabriformis* (*pyinkado*) is probably one of the best India woods for this purpose. Blocks of this species laid in the streets of Bombay and Rangoon lasted 20 years. *Tectona grandis* (teak) is also known to be good. *Hardwickia binata* (*anjan*) has also been used in India and very favourably reported on. *Xylia xylocarpa* was tried in Bombay for treated road blocks and found excellent, but wood block paving in Indian cities has never been regarded with a very favourable eye by engineers, chiefly because they are afraid the blocks will rot or be destroyed by white ants, and there is always the possibility of water penetrating under the blocks during rainy weather, and forcing the blocks to separate from their foundation and rise above the road surface.

Ship building. See p. 196

Shoe heels. See p. 199

XXXV. Shuttles.

The subject of shuttles is a very important one in India. All cotton, jute, wool, and other textile mills use wooden shuttles in

large quantities. The majority of these shuttles are imported from Europe and Japan, either in the form of the finished article or as 'blanks' for manufacture in India. Cornel wood (the chief wood used), is imported from America but mostly through English or European houses, which supply 80 to 90 per cent. of the demand. The remainder, mostly of a cheaper type of shuttle, come from Japan. The import figures for shuttles coming into I ndia are in the neighbourhood of 6,000 to 7,000 gross per annum, valued at about 8 to 9 lakhs of rupees. There are at present three small shuttle factories in India, all in Bombay. They use imported wood mostly, but as supplies are precarious they are anxious to find Indian substitutes. In addition to these three factories, some simpler types of shuttle, mostly for hand looms, are made by hand in some centres. There is considerable scope for shuttle manufacture in India, and the Forest Research Institute started a special investigation on the subject a year or two back.

After manufacturing trials and mill tests the following species appear to be the most promising :—

Diospyros melanoxylon (ebony) white wood*
Buxus sempervirens (boxwood).
Gardenia latifolia (gardenia).
Saccopetalum tomentosum.
Ougeinia dalbergiodes (*sandan*).*
Acacia arabica (*babul*).*
*Schrebera swietenioides**
Thespesia populnea (bhendi).
Lagerstroemia lanceolata (*benteak*).
Mitragyna parvifolia (*kaim*).
Dalbergia latifolia (rosewood).
Dalbergia sissoo (*sissoo*).
Hopea glabra (syn *H. wightiana)* (*hopea*), and possibly
Parrotia jacquemontiana.

The service tests carried out on the shuttles made of Indian timbers have indicated that the species marked with an asterisk, give a life of 50 per cent to 70 per cent of the imported cornel.

The Forest Research Institute is experimenting with shuttles made of compregnated wood, and this may be the full solution to the problem in India.

Spars, See p. 197.

XXXVI. Sporting requisites

This heading comprises a large number of articles for which different qualities of woods are required.

Billiard Cues.—In Europe billiard cue shafts are made of ash and maple. In India, the following three woods have been tried and found suitable :—*tendu* (*Diospyros melanoxylon*) white wood, *dhaman* (*Grewia tiliaefolia*) sapwood, *Polyalthia fragrans*, and *Saccopetalum tomentosum*. *Chooi* (Andaman bow wood) has been found excellent. For the butts of cues, ebony, *Hardwickia pinnata* and *Dysoxylum glandulosum* have been used with success.

Cricket Bats.—The best English cricket bats are made of cricket bat willow (*Salix alba*). The cricket bat willow grown in Kashmir is said to be a hybrid (*Salix alba* × *fragilis*), but some is also *Salix babylonica*. Supplies of cricket bat willow from Kashmir are limited and controlled, and only meet a small portion of the possible demand. Attempts to find a substitute have not met with much success. The wood of the Chinese tallow tree (*Sapium sebiferum*) is one of the best so far tried, but it is not of the same high standard as cricket bat willow. *Populus euphratica* (Indian poplar) has also been used for cheap types of bat.

Fishing Rods.—In the past, European manufacturers of fishing rods used to take large quantities of the solid bamboo (*Dendrocalamus strictus*), also known in the trade as "Calcutta canes", from India for making "split cane" fishing rods. Owing to slackness on the part of the Indian suppliers, however, the Indian supplies were found to be very variable and not uniform in quality, and the trade was lost to India in favour of a Chinese bamboo known as the "palankona" or "Tonkin cane", a strong and fairly thick-walled bamboo with very small nodes. On account of the disturbed conditions in China at present, European importers are again showing some interest in Indian supplies, but if India wants to recapture this market all bamboos supplied must be properly graded and passed for export as is done in China. Special plantations might even be grown for this market, as is done in China and Japan, and this would ensure that the culms are more or less straight and uniform.

In India itself, for cheap rods, bamboos are chiefly used, the "*ringal*", (*Arundinaria falcata*) being the best known.

For solid fishing rods, *Caryota* (sago palm) and *Heterophragma adenophyllum* have been used. The last named was reported on as satisfactory, but it is doubtful if India possesses any wood which can compare with greenheart (*Nectandra* sp., a South American wood) for this purpose. The Forest Research Institute has at times experimented with several Indian woods for rod making and the best so far have been black *chuglam* (*Terminalia amanii*) and *chooi* (*Sageraea elliptica*). The last named, although extremely strong and pliable, lacks the elasticity

of greenheart; it is however excellent for big game fishing. *Parrotia jacquemontiana* is also fairly good for the bottom and middle sections of fishing rods, but has been reported on as unsuitable for tops.

Golf Clubs.—Imported wooden golf clubs are usually made of South American hickory (*Hickoria* spp.), while ash (*Fraxinus* spp.) is used for some cheaper types of club.

Several Indian woods have been tried at one time or another for golf club shafts and some approach hickory very closely. Black *chuglam* (*Terminalia manii*), *chooi* (*Sageraea elliptica*), *Grewia* species, *Anogeissus* species and Andaman *pyinma* (*Largerstroemia hypoleuca*) have been tested by experienced players and sometimes well reported on while others have declared that they are not suitable.

For the heads of wooden clubs, *pyinkada* (*Xylia dolabriformis*), *mesua* (*Mesua ferrea*), *babul* (*Acacia arabica*) and *pussur* (*Carapa moluccensis*), *Cotoneaster bacillaris*, *Tamarindus indica*, *Dalbergia latifolia* and *Chloroxylon swietenia* have all been used with success. *Babul* has been approved for this purpose by a large European firm and pussur has been used in Australia.

Gun Stocks.—The wood most used for sporting gun stocks is walnut (*Juglans regia* and *Juglans nigra*), and this timber is undoubtedly the best selection for the purpose.

For cheaper types of "country made" guns and sporting rifles several Indian woods have been used from time to time. Amongst the most favourable the following may be mentioned :— *Dalbergia* species, *Gmelina arborea* (*gamari*), *Lagerstroemia flos-reginae* (*jarul*), *Morus* species (mulberry), *Tectona grandis* (teak), *Artocarpus hirsuta* (*aini*), *Albizzia lebbek* (*kokko*) and *Pterocarpus marsupium* (*bijasal*).

Hockey Sticks.—Hockey sticks in Western countries are made of ash. In India, mulberry (*Morus alba*) has been proved to make a most excellent stick, and it is now the standard wood for this purpose. Another wood used as a substitute for mulberry is *Celtis australis* from Kashmir which makes a satisfactory hockey stick, but is not quite up to the standard of mulberry.

Skis—The demand for Indian woods for skis has been on the increase during the last few years, and several timbers were tested by the Ski Club of India. The timbers usually employed for this purpose are ash and hickory, but after fairly exhaustive trials it was reported that *sissoo* (*Dalbergia sissoo*) and axlewood (*Anogeissus latifolia*) seemed to be superior to ash for ski blades.

Stumps and Bales.—Mulberry is most commonly used for stumps and bales in India, but other woods such as *dhaman (Grewia tiliaefolia)*, *Celtis australis* and *Polyalthia fragrans* are also very suitable.

Tennis, Badminton and Squash Racquets.—Ash is the wood most commonly used for the frames of racquets, while maple, sycamore, beech, mahogany and other woods are used for the wedge and handles.

In India, mulberry has proved to be an excellent wood for racquet frames, while bird cherry (*Prunus padus*), *Celtis australis*, *sissoo* (*Dalbergia sissoo*), *Polyalthia fragrans*, *asagi* (*Humboldtia brunonis*), *toon* (*Cedrela toona*) and Persian lilac (*Melia azedarach*) have all been used for different parts of racquets with success. Nowadays, laminated racquet frames are popular, and bamboo interspersed with layers of wood seems to be a good combination for this type of work.

XXXVII Tent poles and tent pegs.

Tent Poles are usually of bamboo, but it is not uncommon to see large types of tent poles made of wood. Such poles can be round or square sawn. A good strong wood is advisable, and the most common timbers used for this purpose are *sal*, teak and *dhaman*.

Tent Pegs must be made of a hard tough wood. *Babul* (*Acacia arabiaca*), *sundri* (*Heritiera minor*), *sal* (*Shorea robusta*), *sandan* (*Ougeinia dalbergioidies*), tamarind (*Tamarindus indica*), *ber* (*Zizyphus jujuba*) and *kusum* (*Schleichera trijuga*) are all used for this purpose.

XXXVIII Tobacco pipes.

The roots of *Erica arborea*, a heath not found in India, are universally used for the manufacturing of tobacco pipes known as briar pipes. Several Indian woods have been tried for this purpose, but they all sweated too much and cracked. Burma padauk burr wood and knots of dry teak have been used with success, while bamboo roots and nodes are employed in Burma for cheap pipes. Andaman padauk burr wood might prove suitable for this purpose. *Sissoo* root has passed recent tests well.

Hooker stems are made of *Holarrhena antidysenterica*, *Boehmeria rugulosa*, *Acacia arabica*, *Dalbergia sissoo* and other local timbers.

XXXIX. Turnery, carving, combs, toys, etc.

Very close-grained woods are required for high class turnery and carving. Walnut is much in demand in North India and

Kashmir for this purpose. The sandalwood carvings of Mysore are equally well known. Sissoo and ebony are also used for high class carving and inlay work in North India. Boxwood is also popular but supplies of this wood in India are limited as the cost is high on account of the difficulties of extraction. The following woods are all used for cheap turnery, combs and toys :—

Haldu, *aini*, jack, *Cinnamomum* species, ebony, *Gardenia* species, *piney*, *kaim*, olive ; *parrotia*, red sanders, *gamari*, *kuthan Wrightia* species, *Holarrhena antidysenterica* and *Boehmeria rugulosa*.

Erythrina species, *Gyrocarpus jacquini*, *Bauhinia malabarica* are used for toys in Mysore, the first two being favourites for making imitation fruits, carved animals, and school models.

Hymenodictyon excelsum (*kuthan*) is reputed to be the best toy wood in the United Provinces, while *Adina cordifolia* (*haldu*), *Gardenia latifolia* and *Holarrhena antidysenterica* are also popular for the same purpose in this Province.

Ficus glomerata and mango wood are also used but are not so reliable as the above 4 species.

Indian combs such as those used by the Sikhs in the hair are usually made of boxwood, *haldu*, ebony and sandalwood. Cheaper combs are made of *bæl*, *Carissa* species, *Cratæva religiosa*, gardenia, *gamari*, *Wrightia* species, *Holarrhena antidysenterica*, *Mitragyna* species, *Premna latifolia* and *Gyrocarpus jacquini* (Mysore).

Tool handles. See p. 193.

XL. Umbrella handles and walking sticks.

There is a very large demand in India for umbrellas, and handles are required for these in very large numbers. The two most important manufacturing centres are Calcutta and Calicut.

The most common type of handle seen is that in which the shaft and handle are made of one piece of bamboo, the handle having been bent into a crook over an open fire. A common practice is to insert a wire down the centre of the bamboo. This gives additional strength and helps in retaining the shape of the handle crook. The tops of *Dendrocalamus strictus* are sometimes used for this purpose. *Pseudostachyum polymorphum* from Assam, and *Oxytenanthera monostigma* from Bombay, *Arundinaria jaunsarensis* and *Arundinaria falconeri* from the United Provinces have also been found very suitable for the purpose. In Calcutta, the most popular bamboo for this purpose passes under the vernacular name of *bazali*. It comes from Chittagong and is

probably *Pseudostachyum polymorphum*. Wood is also used for the shafts and handles of umbrellas. Sometimes the carved or worked handle is separate to the shaft, while in other cases young shoots of suitable species are used with the handle bent into a crook under steam or heat. Young ash stems and coppice and branch shoots of *Cotoneaster* species, *Olea ferruginea*, *Diospyros* species, *Prunus puddum*, *Randia dumetorum*, *Quercus dilatata*. *Staphylea emodi* and mulberry are frequently seen being used as bent crook umbrella handles and walking sticks.

Other woods used for walking sticks include *Cratægus crenulata*, *Zanthoxylum alatum*, *Feronia* species, *Caryopteris wallichiana*, *Zizyphus jujuba*, *Pterospermum acerifolium*, *Dalbergia sissoo* and *Celtis australis*. Ornamental walking sticks are often made of *Santalum album*, *Diospyros* species (ebony) *Olea ferruginea*, and the hard outer portion of the palms *Caryota urens*, *Borassus flabellifer* and *Cocos nucifera*. The best cane sticks are made from *Calamus viminalis* (the rattan), *Calamus latifolius* and *Calamus acanthospathus*.

For wooden umbrella handles which are separate units fixed to a shaft of a different species, a very large variety of timbers are used. Freak branch and root joints are very popular for this purpose, while carved and shaped handles of a vast variety of species are to be seen throughout the length and breadth of India.

Vats. See page 207.

Wagon building. See page 220.

APPENDIX I

Strength Data

India and Burma grow a large number of species of wood, having widely different properties. Some species, such as *semul* (*Bombax*), *papita* (*Sterculia*), *pangara* (*Erythrina*) etc. are so soft that they can be marked by a finger nail, while others, like bullet wood (*Mimusops*), *anjan* (*Hardwickia*), and *Mesua*, are so hard that they will, after drying, blunt any sharp tool in the first few cuts. There is, thus, a very wide scope in India, for the selection of suitable timbers for almost every purpose. But only a few most prominent species, such as teak, *sal*, *deodar*, *sissoo*, *hopea* etc. have been used in the past, all other timbers being called "kukat," which actually meant inferior timbers. The strength and other properties of the popular timbers have been well known by long usage, and, as large quantities were formerly available, sufficient attention was not given to the general utilization of the so-called "kukats", although many of them were used locally.

With the increase in demand for timber, and the utilization of species so far not commonly known, accurate knowledge of their strength and other properties is very essential in order to utilize them to their best advantage and to convince timber users of their merits. The Timber Testing Section of the Forest Research Institute has determined the physical and mechanical properties of over 225 consignments of various timber species from all over India and Burma. Tables of comparative suitability, prepared from these data, are given in this Book for all the species tested.

Comparative Suitability.

Tables of actual strength under different conditions of loading, and Tables of safe working stresses for design purposes, have been published from time to time for the use of engineers. Although such Tables are very useful to engineers, they have much less appeal to other users of timber, the majority of whom are not equipped with the technical knowledge required, but are, all the same, interested in knowing the comparative merits of one species over the other. A Table of the comparative suitability of Indian timbers has been prepared for the use of such people. In this Table, the suitability of any species for different conditions of loading has been shown by index figures as a percentage of teak, which is the most important and the best known, all purpose timber of India.

The index figure for any property has been calculated by taking into consideration every fundamental strength function bearing upon that property, and proper consideration has been given to each in order to make the figures as representative as possible. For example, the property "strength as a beam" includes the modulus of rupture in static bending, the fibre stress at the elastic limit in static bending, and the fibre stress at the elastic limit in impact bending, modified by suitable adjusting and weighting of factors in arriving at the final figure. The index figures and the stick graphs prepared from them for any species are, therefore, expected to give as true a picture as possible of the properties of that species and greatly facilitate theselection of a timber for specific purposes.

Suitability figures for eight different properties have been calculated by taking into consideration the various strength functions of both green and seasoned timber as shown on the next page :—

TABLE 1.

Suitability.	Strength functions and other properties considered.
Weight	Specific gravity based on weight oven dry and the volume of seasoned timber (approximately at 12% moisture content).
Strength as a beam	Modulus of rupture and fibre stress at the elastic limit in static bending.
	Fibre stress at the elastic limit in impact bending.
Stiffness as a beam	Modulus of elasticity in static bending.
	Modulus of elasticity in impact bending.
Suitability as a post	Max. crushing strength and strength at the elastic limit in compression parallel to grain.
	Modulus of elasticity in static bending.
Shock resisting ability	Work to max. load and total work in static bending.
	Max. height of drop in impact bending.
Retention of shape	Shrinkage green to oven dry in volume and in the radial and tangential directions.
	Ratio of tangential to radial shrinkage.
Shear	Shearing strength in the radial and tangential directions.
Hardness	Fibre stress at the elastic limit in compression perpendicular to the grain. Radial, tangential and end hardness.

There may be genuine differences of opinion among different research workers as to the details of working out these index figures of comparative suitability. It has, however, been found from experience, that the figures for any property given in Table 2 arrange the different species of timbers roughly in the order of their merit as far as that property is concerned. Since the start of the present war, the comparative suitability tables have been very much in demand by the Ordnance and Supply Departments, military contractors, timber merchants etc., and have been extremely useful in the selection of Indian timbers for various purposes connected with the war. Such index figures have also been calculated for some foreign timbers that are commonly imported into India. These are given in Table 3. They are useful in the selection of Indian substitutes for such purposes.

Selection of timber for Specific uses

It is often necessary to make a selection of timber for a particular use from several available species. Table 2, showing the comparative suitability of various species by index figures, is especially helpful in making a proper choice. In order to facilitate such selection, Table 4, has been prepared showing the qualities that must be possessed by any timber so as to be suitable for various common purposes.

EXPLANATION OF COMPARATIVE SUITABILITY TABLE 2.

Comparative suitability of Indian timbers expressed as percentages of teak.

Column 1 gives the serial No. of the species.

Column 2 gives the Botanical names of different species arranged in their alphabetical order with the Indian trade name shown in italics and the English name in bold Roman. A few of the most common other Indian names have also been given in small italics.

Column 3 gives the locality from which the timber tested was obtained.

Column 4 gives the actual weight of seasoned timber at 12% moisture content in lbs. per cubic foot.

Column 5 gives the average weight of any species as a percentage of the average weight of teak. As the weight depends on the percentage of moisture contained in the wood, the weight of seasoned wood, containing 12% moisture, has been taken for calculation.

Column 6 gives the comparative strength of any timber when used as a beam. An index figure of about 100 can be taken to represent a very strong timber.

Column 7 gives the comparative stiffness of any timber. A greater index figure shows that the particular timber is more stiff and will deflect less when loaded as a beam. 100 can be taken to represent a stiff species.

Column 8 gives the suitability of a timber for use as a post or strut or resistance to pure compressive stresses. 100 may be taken to represent a very strong species.

Column 9 gives the shock resisting ability of any timber. A greater index figure shows that the timber is more tough. This property is very important in the selection of timbers for such purposes as helves and tool handles, camp furniture etc. An index figure of more than about 125 shows the timber to be fairly tough and suitable for such purposes.

Column 10 shows the property of retention of shape. This figure is based on the radial, tangential and volumetric shrinkages from the green to dry condition of small clear specimens, and on the ratio

of the tangential to radial shrinkage. They give an idea of the combined effect of shrinkage, warping and twisting of any timber and are helpful in arranging the different species according to their merit. The more nearly the index figure approaches 100, the greater the degree of freedom from shrinkage and warping and the timber approaches teak which is superior to almost all timbers in the world in this respect. Timbers having a high figure for retention of shape can also be expected to be less susceptible to variations of size owing to atmospheric changes after they are seasoned. A suitability figure of more than 75 shows that the timber is suitable for making furniture. Panels made of such timber, may be expected to work little owing to climatic changes.

Work on the actual swelling and shrinking of seasoned timber with variations of the atmospheric humidity is in progress.

Column 11 gives the comparative shear strength of any timber. It shows the suitability of a species for making bolted connections, joints, short beams etc.

Column 12 gives the comparative hardness of any timber. It shows resistance to indentation, wear and tear, and bearing pressure, and is useful in the selection of timber for making articles such as bearings of shafts and spindles, packing pieces, paving blocks, flooring etc. An index figure of about 150 and up represents very hard timbers such as *sal*, rosewood, *babul* etc. that are difficult to work. *Papita* (*Sterculia*) is so soft that its hardness figure is only 25, while for *kusum* (*Schleichera trijuga*), which is an exceptionally hard timber, it is 260.

Column 13 gives the serial No. of the species for ease of reference.

TABLE 2.—The Comparative Suitability of

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12 % moisture.
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
1	*Abies pindrow* FIR, *partal*	Simla, Punjab	33
2	,, ,, ,, ,,	Kishanganga, Kashmir	26
3	,, ,, ,, ,,	Kaghan, N.W.F.P.	28
4	*Acacia arabica BABUL, kikar*	Hyderabad, Sind	52
5	*Acer* spp. MAPLE	Jamuna Tons, Tehri Garhwal State, U.P.	39
6	,, ,, ,,	Seraj, Punjab	39
7	,, ,, ,,	TehriGarhwalState, U.P.	38
8	,, ,, ,,	Lower Bashahr, Punjab	30
9	*Acrocarpus fraxinifolius MUNDANI*	Malabar, Madras	43
10	*Adina cordifolia HALDU*	Haldwani, U.P.	41
11	,, ,, ,,	S. Coimbatore, Madras	43
12	,, ,, ,,	Saranda, Bihar	42
13	*Aegle marmelos BEL*	Gonda, U.P.	56
14	*Ailanthus grandis GOKUL*	Buxa, Bengal	25
15	*Albizzia lebbek KOKKO*	S. Andaman.	40
*16	*Albizzia odoratissima BLACK SIRIS*	S. Coimbatore, Madras	*46*
17	*Albizzia procera WHITE SIRIS*	Dehra Dun, U. P.	40
18	*Alnus nepalensis* ALDER	Darjeeling, Bengal.	23
19	*Alstonia scholaris SHAITAN WOOD*	N. Mangalore, Madras	26
20	*Altingia excelsa JUTILI*	Lakhimpur, Assam	50

*All values of this species are tentative.

Indian timbers expressed as percentages of teak.

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
75	70	85	80	75	65	80	65	1
60	55	70	65	†60	60	60	40	2
65	60	75	75	†75	65	70	45	3
120	120	95	105	170	70	180	185	4
90	75	80	70	145	55	130	80	5
90	70	75	65	125	—	130	80	6
90	60	65	55	130	60	120	75	7
70	55	55	50	75	65	95	50	8
100	100	105	100	110	80	135	105	9
95	75	75	80	80	80	110	110	10
100	75	80	75	85	85	100	100	11
100	95	85	90	105	75	120	115	12
130	80	80	80	90	60	165	185	13
60	55	70	55	55	85	70	35	14
95	85	100	90	85	80	125	100	15
105	*115*	*120*	*125*	*140*	*90*	*180*	*175*	16
95	85	80	85	140	75	130	105	17
55	45	60	50	40	75	60	35	18
60	50	55	50	35	85	60	40	19
115	100	105	110	95	60	140	150	20

†This value is tentative.

TABLE 2.—The Comparative Suitability of

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12 % moisture.
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
21	*Amoora rohituka AMOORA*	Nowgong, Assam	44
22	*Amoora wallichii* ,,	Katha, Burma	39
23	*Anisoptera glabra KAUNGHMU*	Insein, Burma	37
24	*Anogeissus acuminata YON, phasi*	Pyinmana, Burma	55
25	,, ,, ,, ,,	Daspalla State, Orissa	53
26	*Anogeissus latifolia* AXLE-WOOD, *bakli, dhaura*	Dehra Dun. U. P.	56
27	,, ,, ,,	S. Coimbatore, Madras	60
28	*Anogeissus pendula KARDHAI*	Jhansi, U. P.	58
29	*Anthocephalus cadamba KADAM*	N. Toungoo, Burma	30
30	*Artocarpus chaplasha CHAPLASH*	Lakhimpur, Assam	32
31	*Artocarpus hirsuta AINI*	S. Manglore, Madras	37
32	*Artocarpus interifolia*, JACK *kathal*	,, ,. (Hill grown), ,,	38
33	,, ,, ,, ,,	,, ,, (Plain grown) ,,	36
34	*Balanocarpus utilis KARUNG KONGOO*	Tinnevelley, Madras	62
35	*Bassia butyracea HILL MAHUA*	S. Andaman	49
36	*Bassia latifolia MAHUA*	Jubbulpore, C.P.	58
37	*Berrya ammonilla* TRINCOMALEE WOOD	Insein, Burma	60

Indian timbers expressed as percentages of teak. *(Cont.)*

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.:
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
105	90	90	85	100	60	125	125	21
90	80	95	85	95	50	95	80	22
85	70	75	70	85	65	90	70	23
130	120	120	115	150	60	155	175	24
125	105	105	100	180	65	150	145	25
130	95	90	80	165	65	135	150	26
140	105	105	95	†*140*	65	135	175	27
135	100	85	85	215	65	160	180	28
70	65	75	65	80	75	85	60	29
75	80	75	80	75	85	100	90	30
90	90	90	95	90	95	90	95	31
90	85	85	85	85	80	115	110	32
85	65	65	65	70	95	110	105	33
145	145	150	140	170	65	175	230	34
115	95	95	90	105	60	115	130	35
135	75	80	75	100	50	120	165	36
140	110	115	110	165	55	130	130	37

†This value is tentative.

TABLE 2.—The Comparative Suitability of

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12% moisture.
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
38	*Bischofia javanica* BISHOP WOOD	S. Coimbatore, Madras	48
39	*Bombax insigne SEMUL*	S. Andaman	23
40	*Bombax malabaricum SEMUL*	Dehra Dun, U. P.	23
41	*Boswellia serrata SALAI*	Hazaribagh, Bihar	34
42	*Bridelia retusa KASI*	Saranda, Bihar	36
43	*Calophyllum* spp. *POON*	Cachar, Assam	39
44	*Calophyllum tomentosum POON*	S. Coimbatore, Madras	38
45	„ „ „	S. Kanara, Bombay	41
46	*Calophyllum wightianum* „	S. Kanara, Bombay	43
47	*Canarium euphyllum DHUP*	S. Andaman	26
48	*Canarium strictum* „	N. Mangalore, Madras	41
49	*Carallia lucida MANIAWGA*	Nowgong, Assam	47
50	*Carapa moluccensis PUSSUR*	Tavoy, Burma	49
51	*Careya arborea KUMBI*	Haldwani, U. P.	55
52	*Castanopsis hystrix* INDIAN CHESTNUT	Darjeeling, Bengal	39
*53	*Casuarina equisetifolia* *CASUARINA*	Puri, Orissa	*55*
54	*Cedrela serrata TOON*	Maymyo, Burma	35
55	*Cedrela toona* „	Dehra Dun, U. P.	30
56	*Cedrus deodara DEODAR*	Simla, Punjab	35
*57	*Chloroxylon swietenia* EAST INDIAN SATIN WOOD	Hoshangabad, C. P.	*58*

*All values of this species are tentative.

Indian timbers expressed as percentages of teak. *(Cont.)*

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
110	70	80	70	65	35	100	95	38
55	45	50	50	50	90	45	35	39
55	45	45	45	55	90	55	35	40
80	55	60	55	65	90	85	60	41
85	70	85	75	85	80	100	85	42
90	85	90	85	105	65	115	100	43
90	85	95	85	85	65	105	85	44
95	90	90	85	80	65	85	95	45
100	80	80	80	90	65	110	110	46
60	50	70	55	55	70	70	40	47
95	85	100	85	95	65	100	85	48
110	115	110	105	120	60	130	125	49
115	95	95	100	95	80	100	130	50
130	80	80	80	110	50	135	150	51
90	75	90	75	85	55	90	75	52
115	*85*	*100*	*85*	*135*	*50*	*150*	*125*	53
80	75	85	85	85	75	115	80	54
70	55	65	60	60	65	100	65	55
80	80	80	85	60	85	90	70	56
130	*110*	*105*	*105*	*140*	*60*	*160*	*165*	57

TABLE 2.—The Comparative Suitability of

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12 % moisture.
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
58	*Chloroxylon swietenia* EAST INDIAN SATIN WOOD	Vizagapatam, Madras	67
59	*Chukrasia tabularis* *CHICKRASSY*	Buxa, Bengal	42
60	,, ,, ,,	Katha, Burma	39
61	*Cinnamomum iners* CINNAMON	Tavoy, Burma	37
62	*Cinnamomum inunctum* ,,	Tavoy, Burma	43
63	*Cryptomeria japonica SUJI*	Darjeeling, Bengal	16
64	*Cullenia excelsa KARANI*	Malabar, Madras	39
65	*Cupressus torulosa* CYPRESS	Garhwal, U. P.	32
66	*Cynometra polyandra PING*	Sylhet, Assam	56
67	*Dalbergia cultrata YINDAIK*	N. Toungoo, Burma	58
68	*Dalbergia latifolia* INDIAN ROSE WOOD	S. Chanda, C. P.	55
69	,, ,, ,, ,,	Malabar, Madras	47
70	*Dalbergia sissoo SISSOO*	Dehra Dun, U. P.	50
71	,, ,, ,,	Hazaribagh, Bihar	48
72	,, ,, ,,	Hoshiarpur, Punjab	50
73	,, ,, ,,	Jalpaiguri, Bengal	47
74	*Dichopsis elliptica PALI*	Malabar, Madras	38
75	*Dichopsis polyantha TALI*	Cachar, Assam	46
76	*Dillenia indica DILLENIA*	Chittagong Hill tracts, Bengal	40
77	*Dillenia pentagyna* ,,	Buxa, Bengal	39

Indian timbers expressed as percentages of teak. *(Cont.)*

Comparative Suitability.								Serial No.
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
155	110	105	115	115	70	180	195	58
95	75	80	70	90	75	120	110	59
90	90	95	90	105	75	125	100	60
90	85	95	90	95	70	90	75	61
100	75	100	80	80	65	80	65	62
40	25	20	25	35	70	50	20	63
90	95	105	100	105	70	70	85	64
75	70	80	75	60	85	65	60	65
130	115	115	115	155	55	140	175	66
135	105	105	90	185	55	145	165	67
130	90	90	85	125	80	135	175	68
110	95	85	85	145	80	135	155	69
120	95	90	85	140	80	125	130	70
115	90	80	85	140	90	145	140	71
115	80	70	70	135	80	145	130	72
110	90	90	85	140	80	125	125	73
90	90	105	95	100	65	85	90	74
105	90	100	95	105	60	130	120	75
95	80	80	80	85	55	95	80	76
90	80	75	70	75	65	110	90	77

TABLE 2.—The Comparative Suitability of

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12% moisture.
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
78	*Diospyros melanoxylon* EBONY	Nagpur, C. P.	51
79	*Diospyros pyrrhocarpa* ,,	N. Andaman	53
80	*Dipterocarpus alatus GURJUN*	Insein, Burma	42
81	*Dipterocarpus grandiflorus* ,,	N. Andaman	47
82	*Dipterocarpus griffithii* ,,	Insein, Burma	48
83	*Dipterocarpus kerrii* ,,	Mergui, Burma	49
84	*D. macrocarpus HOLLONG*	Lakhimpur, Assam	45
85	*Dipterocarpus tuberculatus ENG*	Insein, Burma	53
86	*D. turbinatus GURJUN*	,, ,,	48
87	*Duabanga sonneratioides LAMPATI*	Kurseong, Bengal	30
88	*Dysoxylum malabaricum* WHITE CEDAR	S. Coimbatore, Madras	46
89	*Elaeocarpus tuberculatus RUDRAKSHI*	N. Mangalore, Madras	29
90	*Eucalyptus eugenioides* EUCALYPTUS	Nilgiris, Madras	53
91	*Eugenia gardneri JAMAN*	S. Mangalore, Madras	59
92	*Eugenia jambolana* ,,	Gonda, U. P.	48
93	*Eugenia* spp. ,,	Cachar, Assam	52
94	*Fraxinus excelsior* ASH	Chamba State, Punjab	45
95	*Fraxinus micrantha* ,,	Nainital, U. P.	44
96	*Garuga pinnata GARUGA*	Dehra Dun, U. P.	36
97	*Gmelina arborea GAMARI*	Haldwani, U. P.	31

Indian timbers expressed as percentages of teak. *(Cont.)*

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.:
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
120	75	75	75	115	60	110	115	78
125	90	90	85	150	—	135	135	79
100	90	100	90	95	60	105	85	80
110	85	100	90	80	45	100	85	81
110	105	120	110	100	45	110	95	82
115	95	125	100	115	45	105	85	83
105	100	120	105	105	50	105	95	84
125	115	120	100	140	55	130	135	85
115	105	125	100	115	55	90	105	86
70	60	70	65	65	75	75	50	87
110	85	95	90	120	60	115	95	88
70	60	75	70	55	80	75	50	89
125	110	110	105	130	55	140	160	90
140	95	110	100	105	50	125	150	91
115	90	100	95	100	60	130	120	92
125	95	95	90	115	55	120	145	93
105	95	100	85	165	65	140	115	94
105	95	105	90	140	70	145	125	95
85	70	65	65	80	85	115	85	96
75	55	60	55	65	85	90	70	97

TABLE 2.—**The Comparative Suitability of**

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12 % moisture
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
98	*Gmelina arborea GAMARI*	insein, Burma	30
99	*Grewia tiliaefolia DHAMAN*	Malabar, Madras	49
100	*Grewia vestita* ,,	Kurseong, Bengal	47
101	*Hardwickia binata ANJAN*	Nimar, C. P.	53
102	*Hardwickia pinnata PINEY*	S. Mangalore, Madras	38
103	*Heritiera minor SUNDRI*	Delta, Burma	65
104	*Heritiera* spp. ,,	Cachar, Assam	54
105	*Heterophragma adenophyllum* KAREN WOOD	Pyinmana, Burma	53
106	*H. roxburghii PALANG*	S. Chanda, C. P.	38
107	*Holoptelea integrifolia* KANJU	Dehra Dun, U. P.	47
108	*Homalium tomentosum* BURMA LANCEWOOD	Pyinmana, Burma	58
109	*Hopea glabra HOPEA*	Palghat, Madras	67
110	*Hopea odorata* ANDAMAN *THINGAN*	S. Tenasserim, Burma	47
111	*Hopea parviflora HOPEA*	S. Mangalore, Madras	58
112	*Hymenodictyon excelsum* KUTHAN	Ramnagar, U. P.	31
113	*Juglans fallax* WALNUT *akhrot*	Jhelum Valley (Low elevation), Kashmir	36
114	,, ,, ,, ,,	Jhelum Valley (High elevation), Kashmir	34
115	*Juglans* spp. ,, ,,	Lower Bashahr, Punjab	38

Indian timbers expressed as percentages of teak. *(Cont.)*

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.:
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
70	60	70	60	70	85	80	60	98
115	110	125	125	145	60	140	155	99
110	100	105	95	165	55	155	130	100
125	75	60	70	125	90	145	180	101
90	80	90	85	90	65	100	85	102
150	110	130	110	130	45	150	175	103
130	115	120	115	150	55	145	150	104
125	105	110	120	115	65	125	180	105
90	75	75	75	80	70	80	80	106
85	65	65	65	100	80	95	80	107
135	105	115	110	130	55	160	175	108
160	125	130	130	155	60	180	225	109
110	100	100	95	100	75	110	130	110
135	120	120	120	130	65	155	200	111
70	50	55	50	55	75	75	50	112
85	80	90	75	105	65	95	70	113
80	70	70	65	90	75	90	65	114
90	75	85	70	115	60	120	70	115

TABLE 2.—The Comparative Suitability of

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12 % moisture.
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
116	*Juglans* spp. WALNUT, *akhrot*	Seraj, Punjab	36
117	„ „ „ „	Tehri Garhwal State, U.P.	36
118	„ „ „ „	Nepal	37
119	*Kayea floribunda KARAL*	Cachar, Assam	51
120	*Lagerstroemia flosreginae JARUL*	Chittagong Hill Tracts, Bengal	40
121	*Lagerstroemia hypoleuca* „	N. Andaman	39
122	*Lagerstroemia lanceolata BENTEAK, nana*	Nilambur, Madras	38
123	„ „ „	N. Kanara, Bombay	46
124	*Lagerstroemia parviflora LENDI*	Dehra Dun, U. P.	46
125	*Lagerstroemia tomentosa LEZA*	Pyinmana, Burma	41
126	*Lannea grandis JHINGAN*	Dehra Dun, U. P.	35
127	*Lophopetalum wightianum BANATI*	N. Mangalore, Madras	29
128	*Machilus macrantha MACHILUS*	„ „ „	32
129	*Machilus odoratissima* „	Kurseong, Bengal	43
130	*Mallotus philippinensis RAINI*	Dehra Dun, U. P.	41
131	*Mangifera indica* MANGO *am*	Puri, Orissa	41
132	*Melanorrhoea usitata THITSI*	Meiktila, Burma	53
133	*Mesua ferrea MESUA, nagkesar*	Sibsagar, Assam	60
134	*Michelia cathcartii CHAMP*	Kurseong, Bengal	33
135	*Michelia champaca* „	Kurseong, „	31
136	*Michelia excelsa* „	„ „	32

Indian timbers expressed as percentages of teak. *(Cont.)*

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
85	80	85	80	105	75	115	70	116
85	70	80	75	90	70	105	65	117
90	80	90	80	105	50	105	75	118
120	105	100	95	155	50	125	145	119
95	80	85	75	85	65	100	105	120
90	80	80	75	85	70	100	80	121
90	80	95	85	110	65	95	90	122
105	95	105	95	100	60	115	120	123
105	90	100	90	120	60	135	110	124
95	90	100	95	95	70	120	100	125
80	55	50	50	75	85	80	70	126
65	50	60	55	50	80	65	45	127
75	60	65	60	70	75	80	55	128
100	80	95	85	90	60	120	95	129
95	70	65	60	110	70	110	90	130
95	75	80	75	100	95	105	90	131
125	70	90	85	55	80	105	150	132
140	145	150	150	160	55	145	215	133
75	65	90	75	75	65	95	55	134
70	70	75	70	75	90	85	65	135
75	75	90	80	75	65	65	60	136

TABLE 2.—The Comparative Suitability of

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12 % moisture.
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
137	*Michelia montana CHAMP*	Jalpaiguri, Bengal	32
138	*Michelia oblonga* ,,	Buxa, ,,	27
139	*Miliusa velutina DOMSAL*	Dehra Dun, U. P.	47
140	*Mimusops elengi* BULLET WOOD, *bakul*	S. Coimbatore, Madras	55
141	*M. littoralis* BULLET WOOD	S. Andaman	69
142	*Mitragyna diversifolia BINGA*	Pyinmana, Burma	41
143	*Mitragyna parvifolia KAIM*	Haldwani, U. P.	41
144	*Morus alba* MULBERRY *tooti*	Changamanga, Punjab	42
145	,, ,, ,, ,,	Lahore, ,,	45
146	*Morus serrata* ,, ,,	Chamba State, ,,	41
147	*Myristica attenuata RUKTMARA*	N. Mangalore, Madras	32
*148	*Ougeinia dalbergioides SANDAN, tiwas*	Hoshangabad, C. P.	54
149	*Parashorea stellata* TAVOY WOOD	Tharrawaddy, Burma	45
150	*Parishia insignis RED DHUP*	S. Andaman	30
151	*Pentace burmanica THITKA*	Burma	40
152	*Pentace griffithii THITSHO*	Tavoy, Burma	54
153	*Pentacme suavis INGYIN*	Pyinmana, Burma	57
154	*Phoebe goalparensis BONSUM*	Sadiya, Assam	32
155	*Phoebe hainesiana* ,,	Nowgong, Assam	35
156	*Picea morinda* SPRUCE, *partal*	Simla, Punjab	29

*All values of this species are tentative.

Indian timbers expressed as percentages of teak. *(Cont.)*

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
75	70	75	70	75	80	85	65	137
65	50	60	50	65	80	70	45	138
110	70	70	70	90	65	140	105	139
130	105	115	100	135	65	150	160	140
160	140	155	140	155	50	175	250	141
95	95	85	90	105	65	110	105	142
95	75	70	75	95	65	110	100	143
100	85	85	80	135	65	145	125	144
105	75	70	65	175	65	145	105	145
95	70	75	60	130	80	115	90	146
75	55	75	60	45	65	90	50	147
120	*80*	*75*	*80*	*120*	*60*	*140*	*145*	148
105	90	115	105	95	55	115	85	149
70	50	75	55	50	65	75	40	150
95	95	95	95	100	75	110	110	151
125	130	145	135	165	60	155	140	152
135	115	125	115	125	60	130	155	153
75	65	70	65	65	75	90	55	154
80	80	80	80	80	75	95	70	155
65	60	75	75	55	70	70	55	156

TABLE 2.—The Comparative Suitability of

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12 % moisture.
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
157	*Picea morinda* SPRUCE, *partal*	Kishanganga, Kashmir	31
158	,, ,, ,, ,,	Kaghan, N. W. F. P.	30
*159	,, ,, ,, ,,	Kalatope, Punjab	*31*
160	*Pinus excelsa* BLUE PINE, *kail*	Rawalpindi, ,,	32
161	*Pinus insignis*	Madura, Madras	39
162	*Pinus longifolia CHIR*	Rawalpindi, Punjab	38
163	,, ,, ,, (twisted)	Ranikhet, U. P.	33
164	,, ,, ,,	,, ,,	33
165	,, ,, ,, ,,	Dehra Dun, U. P.	38
166	*Planchonia andamanica* RED BOMBWAY	S. Andaman	57
167	*Podocarpus neriifolia THITMIN*	,, ,,	33
168	*Podocarpus wallichianus* ,,	Tavoy, Burma	34
169	*Poeciloneuron indicum* BALLAGI	N. Mangalore Madras	71
170	*Polyalthia fragrans NEDUNAR*	Malabar, ,,	32
171	*Pongamia glabra SAYKARANJI*	E. Kanara, Bombay	47
172	*Pterocarpus dalbergioides* ANDAMAN *PADAUK*	N. Andaman	45
173	*Pterocarpus macrocarpus* BURMA *PADAUK*	Mogok, Burma	54
174	*P. marsupium BIJASAL*	Belgaum, Bombay	50
175	*Pterospermum acerifolium HATTIPAILA*	Buxa, Bengal	38

*All values of this species are tentative.

Indian timbers expressed as percentages of teak. *(Cont.)*

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
70	60	75	65	†70	70	75	55	157
70	60	80	70	†70	70	75	50	158
70	*60*	*80*	*70*	*65*	65	*80*	*45*	159
75	55	60	60	55	75	65	40	160
90	70	90	80	80	65	95	75	161
90	70	85	80	80	65	90	70	162
75	50	60	55	45	75	85	50	163
75	65	80	70	80	70	70	50	164
90	65	80	70	80	65	95	65	165
135	100	115	105	105	50	110	145	166
80	75	80	85	55	80	80	75	167
80	70	85	75	75	70	80	70	168
165	140	150	145	145	45	180	265	169
75	70	80	75	65	70	70	60	170
110	80	85	75	125	60	110	100	171
105	100	105	105	100	105	115	130	172
125	135	120	130	160	90	145	195	173
115	105	95	95	135	75	115	135	174
90	85	85	85	125	80	105	100	175

† This value is tentative.

TABLE 2.—The Comparative Suitability o

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12 % moisture.
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
176	*Quercus lamellosa* OAK, *buk*	Darjeeling, Bengal	54
177	*Quercus lineata* ,, *phalat*	,, ,,	54
178	*Saccopetalum tomentosum HOOM*	E. Kanara, Bombay	46
179	*Sageraea elliptica CHOOI*	S. Andaman	54
*180	*Salix* spp INDIAN WILLOW	U. P. and Punjab	*32*
181	*Schima wallichii CHILAUNI*	Buxa, Bengal	43
182	*Schleichera trijuga KUSUM*	Pyinmana, Burma	68
183	*Shorea assamica MAKAI*	Lakhimpur, Assam	34
184	*Shorea obtusa THITYA*	Pyinmana, Burma	65
185	*Shorea robusta SAL*	Balaghat, C. P.	50
186	,, ,, ,,	Kalimpong & Jalpaiguri, Bengal	56
187	,, ,, ,,	North Kheri, Gorakhpur and Haldwani, U. P.	55
188	,, ,, ,,	Kurseong, Bengal	55
189	*Sonneratia apetala KEORA*	Sunderbans, ,,	39
190	*Sterculia campanulata PAPITA*	Insein, Burma	20
191	*Stereospermum chelonoides PADRI WOOD*	Buxa, Bengal	45
192	,, ,, ,,	S. Mangalore, Madras	46
193	*Stereospermum suaveolens PADRI WOOD*	Dehra Dun, U. P.	45
194	*Stereospermum xylocarpum VEDAN KONNAI*	S. Coimbatore, Madras	43
195	*Swintonia floribunda CIVIT*	Insein, Burma	40

*All values of this species are tentative.

Indian timbers expressed as percentages of teak. *(Cont.)*

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.:
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
125	105	120	95	130	45	145	140	176
130	105	120	105	115	45	130	160	177
110	90	95	95	110	60	110	100	178
125	140	125	130	235	60	130	170	179
75	*50*	*50*	*40*	*100*	—	*75*	*50*	180
100	80	95	80	90	50	125	85	181
160	135	140	140	155	50	185	260	182
80	65	80	75	75	65	110	75	183
155	135	150	140	155	55	150	195	184
120	105	110	105	115	60	110	120	185
130	120	130	120	145	55	140	150	186
130	110	110	110	145	60	150	165	187
130	120	130	120	140	55	150	170	188
90	70	70	65	90	70	95	95	189
45	45	50	45	40	80	65	25	190
105	80	80	80	110	75	130	105	191
105	110	115	105	145	70	125	120	192
105	85	80	75	145	70	105	105	193
100	80	80	85	75	85	120	115	194
95	75	95	80	80	75	110	70	195

TABLE 2.—The Comparative Suitability of

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12 % moisture.
1	2	3	4
	Tectona grandis TEAK, *sagwan*	Burma and Malabar	43
196	*Tectona grandis* TEAK, *sagwan*	Malabar, Madras	43
197	,, ,, ,, ,,	S. Chanda, C. P.	38
198	,, ,, ,, ,,	Zigon, Burma	43
199	,, ,, ,, ,, (girdled) ,,	,, ,,	42
200	*Tectona grandis* TEAK, ,,	S. Puri, Orissa	38
201	,, ,, ,, ,,	Angul, ,,	44
202	,, ,, ,, ,,	Hoshangabad, C. P.	39
203	,, ,, ,, ,,	Central Puri, Orissa	40
204	,, ,, ,,	Chittagong Hill Tracts, Bengal	40
205	,, ,, ,, ,,	Kurseong, Bengal	38
206	,, ,, ,, ,,	Nilambur, (Plantation–1854) Madras	38
207	,, ,, ,, ,,	,, (Plantation–1907) Madras	42
208	,, ,, ,, ,,	S. Coimbatore, Madras	46
209	*Terminalia arjuna ARJUN*	Kolhan, Bihar	50
210	*Terminalia belerica BAHERA*	Insein, Burma	50
211	*Terminalia bialata WHITE CHUGLAM*	S. Andaman	43
212	*Terminalia chebula HARDA*, MYRABOLAN	Insein, Burma	57
213	*Terminalia manii BLACK CHUGLAM*	S. Andaman	52
214	*T. myriocarpa HOLLOCK*	Lakhimpur, Assam	38

Indian timbers expressed as percentages of teak.

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	✓
100	90	95	95	85	85	110	105	196
90	75	70	70	65	110	95	85	197
100	100	100	100	105	110	90	90	198
100	105	105	105	105	110	100	105	199
90	85	80	80	100	110	105	90	200
105	90	95	95	80	100	110	120	201
90	85	90	85	105	100	110	85	202
95	90	90	90	115	105	115	105	203
95	95	105	100	110	100	120	90	204
90	95	100	100	110	100	120	90	205
90	95	90	90	110	95	105	95	206
100	105	105	105	120	85	125	110	207
105	100	95	95	—	105	125	125	208
115	75	70	70	135	65	140	135	209
115	100	115	105	110	65	120	115	210
100	90	105	95	105	65	100	100	211
135	100	105	105	125	55	130	185	212
120	95	105	105	115	60	135	145	213
90	75	65	75	80	80	105	80	214

TABLE 2.—The Comparative Suitability of

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12 % moisture.
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
215	*Terminalia paniculata KINDAL*	Nilambur, Madras	49
216	,, ,, ,,	E. Kanara, Bombay	48
217	*Terminalia procera WHITE BOMBWAY, badam*	N. Andaman	39
218	*Terminalia pyrifolia LEIN*	Pyinmana, Burma	46
219	*Terminalia tomentosa* LAUREL, *sain, sajar*	Ramnagar, U. P.	53
220	,, ,, ,, ,,	Malabar, Madras	56
221	*Ulmus wallichiana* ELM	Chamba State, Punjab	32
222	*Vateria indica VELLAPINEY*	N. Mangalore, Madras	36
223	*Vitex altissima MILLA*	E. Kanara, Bombay	58
224	*Xylia dolabriformis IRUL, pyinkado,*	Tharrawaddy, Burma	57
225	*Xylia xylocarpa IRUL*	N. Kanara, Bombay	52

Indian timbers expressed as percentages of teak.

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
115	100	110	105	105	60	110	125	215
110	85	100	85	90	65	105	110	216
90	75	85	75	90	75	100	90	217
110	95	105	100	110	60	115	100	218
125	105	110	95	130	65	115	150	219
130	85	90	85	105	60	125	165	220
75	45	45	40	85	60	70	45	221
85	75	100	85	65	50	80	60	222
135	110	120	115	100	65	150	190	223
135	125	130	135	150	70	155	175	224
125	100	105	105	90	65	155	195	225

TABLE 3.—The Comparative Suitability of Some

Serial No.	SPECIES.	LOCALITY.	Weight lbs./c. ft. of seasoned wood at 12 % moisture.
1	2	3	4
	Tectona grandis **TEAK**, *sagwan*	Burma and Malabar	43
1	*Acer saccharum* SUGAR MAPLE	U. S. A.	44
2	*Betula* spp. SWEET AND YELLOW BIRCH	,,	45
3	*Cornus* spp. DOG WOOD	,,	48
4	*Fagus grandifolia* BEECH	,,	45
5	*Fraxinus americana* WHITE ASH	,,	42
6	,, *excelsior* ASH	England	43
7	*Hicoria* spp. HICKORY	U. S. A.	47
8	,, ,, PECAN HICKORY	,,	45
9	*Juglans* spp. WALNUT	,,	39
10	*Picea sitchensis* SITKA SPRUCE	,,	28
11	*Pseudotsuga taxifolia* DOUGLAS FIR	,,	32
12	*Quercus alba* WHITE OAK	,,	48
13	*Salix* spp. WILLOW	,,	29
14	*Swietenia* spp. MAHOGANY	Central America	32
15	*Ulmus* spp. ELM	U. S. A.	39

Important foreign timbers imported into India

Comparative Suitability.								
Weight.	Strength as a beam.	Stiffness as a beam.	Suitability as a post.	Shock-resisting ability.	Retention of shape.	Shear.	Hardness.	Serial No.
5	6	7	8	9	10	11	12	13
100	100	100	100	100	100	100	100	
105	90	*95*	85	135	55	145	110	1
105	85	*100*	85	165	55	125	90	2
115	70	*70*	70	170	50	135	125	3
105	80	*85*	75	130	50	130	90	4
100	85	*90*	85	155	60	130	100	5
100	80	*90*	75	150	50	140	105	6
110	100	*95*	90	250	45	130	115	7
105	90	*85*	90	195	—	120	130	8
90	80	*75*	80	125	75	105	80	9
65	55	*75*	65	75	65	75	40	10
75	65	*85*	80	70	70	80	50	11
110	80	*80*	80	125	55	125	105	12
65	45	*50*	45	95	55	75	40	13
75	80	*75*	75	90	95	105	70	14
90	70	*75*	70	155	60	110	75	15

Note—Values shown in italics are tentative.

Table 4.

Showing the qualities that must be considered in the selection of any timber for various uses.

'A' *denotes qualities of fundamental importance.*

'B' *denotes qualities that are desirable.*

Serial No.	USES.	Strength as a beam	Stiffness as a beam	Comp. stress or suitability as a post or strut	Shock resisting ability	Retention of shape	Shear	Hardness
1	Agricultural implements...	A	B		A		B	A
2	Axles	A	A	B	A		B	B
3	Beams	A	A		B		A	
4	Bearing and packing blocks					B		A
5	Boat building							
	(a) Decking ...	A	B		B	A	B	B
	(b) Framework ...	A	B	B	A			
	(c) Masts and Spars ...	A	B		A			
	(d) Oars ...	A	A		A			
	(e) Planking ...	A			B	A	B	B
6	Columns		A	A			B	
7	Dowels for timber Structures ...			A		A	A	
8	Flooring	A			B	A		A
9	Furniture	A	B	B	B	A	B	B
10	Heavy carriages and carts	A	A	B	A	B	B	
11	Helves and tool handles for							
	(a) Cutting tools ...	B		A	B		B	A
	(b) Scooping tools ...	A	B		A		B	B
	(c) Striking tools ...	A	A		A		B	B
12	Mathematical instruments		A			A		B
13	Musical instruments ...					A	B	
14	Packing cases ...	A			A	B		B
15	Pattern making ...		A			A		A
16	Picker arms ...	A	A		A		B	B
17	Shuttles		B	B	A	A		A
18	Sleepers	A		B	A			A
19	Spokes	A	B	A	A		B	
20	Sporting goods ...	A	B		A	B		B

Strength of species not tested.

The timber species for which strength data are given in this book have been tested generally from the localities in which they are plentiful. Many species are common to several provinces of India and slight variations in strength are bound to occur according to the type of forests in which they happen to grow. Important species such as teak, *sissoo*, *sal*, *chir*, fir, spruce, walnut, maple etc., have already been tested from several localities. If strength data for species from any particular locality not yet tested are required, the average strength of that species from all the other localities can be taken as a fairly good guide. If, in an emergency, it is necessary to use timbers for which strength data are not available, the strength of another species having about the same weight (preferably from the same genera) can be taken as a rough indication.

APPENDIX II.

The Identification of Timber.

The first thing to realise, is that wood is composed of cells which vary in size and shape and in the direction in which they run. Most of the cells are arranged vertically to the axis of the tree but there are some which run horizontally. Everyone knows that timbers are not all the same to look at. This external difference in the appearance of timber, is due to the different patterns in which the cells are arranged, the different thicknesses of the cell walls, the difference in the size of the cells etc. That is why some woods are hard and others are soft; some are heavy while others are light. All these peculiarities of a timber are ultimately traceable to the cells and the cell aggregates which it contains.

After some experience of handling timbers, one may be able to identify some of them by their general look. But this is possible only in a few cases and even then, too much importance must not be given to features such as colour aud weight, because these features may be misleading. *Colour* in wood is a very variable feature. It varies, not only in different species, but also in the same species. Again, the *weight* of wood varies widely. It differs, not only from species to species, but also within a species. Moreover, a piece of greenwood may be twice as heavy as the same piece when it is dry. It is, therefore, not possible to identify timbers entirely by their weight.

Experience has shown that timbers can be best identified by examination of cell structure visible on the end surface. Two tools, only, are necessary for this examination; a hand lens, or a magnifying glass, and a sharp knife. With the help of these two articles most of the commercial timbers of India can be identified with accuracy.

The Forest Research Institute has published a number of bulletins and leaflets on the identification of timber but, in case of difficulty in the indentification of a timber, a small sample should be sent to the Utilization Officer, who will always be glad to have the timber identified free of charge.

Clearly, correct identification is of the first importance because, unless it is known for certain what a timber is, it is impossible to say whether it is suitable for the purpose for which it is to be used.

APPFNDIX III.

Laminated wood, plywood and compregnated wood.

Improving wood.

Wood has many virtues, but it also has certain vices. The metal suppliers have spent much money in improving their products and it is pretty certain that, after the war, new alloys will come on to the market. But great improvements have taken place in wood. These have been aimed at :-

(1) Overcoming the problem of seasoning large blocks of wood.

(2) Improving the strength of timber across the grain, one of its worst faults.

(3) Preventing expansion and contraction due to the absorption and desorption of moisture.

(4) The production of very large sheets comparable with metal sheets.

(5) General improvement of strength properties.

The means taken to effect these improvements to a lesser or greater degree are :-

(a) Ordinary lamination.

(b) Plywood.

(c) Compregnated wood.

(a) *Ordinary lamination.*

Ordinary lamination of the highest type, as might be expected, is found in aircraft propellors. Here whole boards are glued together to form the blocks from which the blades are carved. By these means seasoning is made easy for, of course, the boards are seasoned before the block is built up. A further very important point is that there can be no hidden defects, as might be the case if a solid block were to be used. For less exacting work boards of even small width can be built up into large blocks. Casein, and vegetable caseins are used as a rule, but, in future, for high class work cold setting synthethic resins of the urea formaldehyde type will come more and more into use.

(b) *Plywood.*

To make plywood, bolts of timber are peeled on a lathe, (or logs are sliced), into thin veneers. In ordinary three-plywood the three veneers are glued together, the grain of the centre ply being at right angles to the grain of the two face veneers. Five-ply, seven-ply, and multi plywoods are similarly made. The

glues used for commercial plywood are the caseins and vegetable caseins, but for high quality plywood, such as those for aircraft, synthetic resin adhesives, completely impervious to water and fungus, are required; these generally necessitate the use of a hot press.

The normal plywood construction, described above, in which the grain of each veneer is at right angles to that of the next, does much to equalise the strength in different directions, but if great equality of strength is required, each veneer (in a multiply) is laid with the grain at an angle of 30° to the next.

As the grain of the different veneers in plywood is running in different directions, there is virtually no expansion and contraction due to moisture absorption and drying.

By using peeled veneers, sheets of great size can be produced, if large lathes and presses are available.

A variation of plywood is block board. In this, 1/4" x 1/4" or 1/2" x 1/2" strips of ordinary wood are glued together. On either side of the board so made, veneers are glued, their grain being at right angles to the main core. In this, also, the expansion and contraction due to moisture is small; block board is excellent for making doors, full advantage being taken of veneers of beauty.

(c) *Compregnated wood.*

In this a pack of synthetic resin treated veneers are subjected to a pressure of about a ton a square inch in a hot press. This is indicated for very highly specialised work such as bearings, pinions, propellors for high powered modern aircraft etc.

In this the veneers may be laid as in plywood, or parallel to each other.

In the table on page 270 the increase in strength obtainable, using *semul*, is compared with that of ordinary teak and *semul*.

The future of plywood in India.

The exceptional circumstances arising from this war has resulted in many plywood factories starting business, many of them on a small scale and manufacturing plywood of most inferior quality. Their supplies of logs are precarious and at a distance from the factories, necessitating expensive transport. Once the war is over these will never be able to compete with the high quality Baltic plywoods which have the advantage of excellent timber supplies and water transport. There are few places in India which will support a big modern plywood factory: perhaps the West Coast and the Assam forests are the only sound localities.

These brief notes on the improvement of wood will be of general interest, but the Forest Research Institute has published considerable literature on the subject, and there are many of first class foreign publications. The Research Institute will always be glad to give advice and assistance.

Timbers suitable for plywood.

The following timbers have been found suitable for commercial plywood.

Acer campbellii.	1st. grade plywood. Liable to fungus attack.
Acrocarpus fraxinifolius.	Soft second grade plywood.
Adina cordifolia.	Second grade plywood suitable for interiors, and hidden parts of furniture.
Ailanthus excelsa.	Second grade plywood, suitable for interior work. Liable to fungus attack.
„ *grandis.*	„ „ „ „
Alnus nepalensis.	First grade plywood for general work but liable to fungus attack.
Amoora canarana.	Second grade plywood.
„ *wallichii.*	Second grade plywood for general work.
Anogeissus latifolia.	Very strong plywood, but not a very common timber for plywood.
Anthocephalus cadamba.	Second grade plywood suitable for interior work.
Artocarpus chaplasha.	A good type of 2nd. grade plywood for general work.
Artocarpus hirsuta.	A good strong second grade plywood suitable for general work.
Bauhinia lawii.	A second grade plywood for general use.
Boswellia serrata.	The sapwood is quite good for second grade plywood for general utility purposes, but it is liable to fungus attack.
Betula alnoides.	1st. grade plywood.
Bombax malabaricum.	Third grade plywood for packing cases where strength is not the main factor. Liable to borer attack.
„ *insigne.*	Second grade plywood for interior work. Liable to borer attack.
Bucklandia populnea.	Second grade plywood for general utility work ; liable to be attacked by borer.

Canarium strictum.	Durable second grade plywood for general utility work and tea chests.
Cedrela toona.	Second grade plywood; general purpose semi-ornamental plywood.
Chukrasia tabularis.	First grade ornamental plywood for decorative and other purposes.
Cullenia excelsa.	Second grade general utility plywood.
Dalbergia latifolia	First grade for ornamental and utility purposes.
„ *sissoo.*	First class plywood for high class decorative and other purposes.
Dillenia pentagyna.	Second grade plywood for interior work.
Dichopsis elliptica.	Second grade plywood above normal strength.
Dipterocarpus alatus.	Strong 2nd. grade plywood for general utility.
„ *turbinatus.* „ *macrocarpus.*	Second grade non-ornamental plywood.
Duabanga sonneratioides.	Second grade plywood for interior work.
Dysoxylum malabaricum.	Second grade plywood of general utility.
Eugenia jambolana.	Second grade plywood for general use and tea chests, if the colour is acceptable.
Gmelina arborea.	Second grade plywood for interior work.
Holoptelea integrifolia.	Second grade plywood for general use.
Hymenodictyon excelsum.	Second grade suitable for interior work.
Juglans regia.	First grade plywood for ornamental and high class work.
Kydia calycina.	Second or third grade plywood for interior work.
Machilus macrantha.	Second grade plywood for general utility.
Mangifera indica.	Second grade plywood for general work. The heartwood is often highly figured and makes a decorative plywood.
Michelia champaca.	First grade plywood for decorative and other purposes.
Morus alba.	Second grade plywood for general use.

Phoebe spp.	Good 2nd. grade plywood for general utility.
Pallaquim ellipticum.	Second grade plywood above normal strength.
Parashorea stellata.	Good second grade plywood for general utility work.
Shorea assamica.	Good second grade plywood for general purposes.
Spondias acuminata.	Second grade plywood for general purposes.
Sterculia alata. „ *urens.*	Cheap grade plywood for rough work. Much liable to blue stain.
Swintonia floribunda.	Second grade plywood for general utility.
„ *mahogany.* *Tectona grandis.*	First class plywoods for decorative and high class work.
Terminalia belerica. „ *myriocarpa.*	Suitable for 2nd. grade plywood for general work.
„ *procera.*	„ „ „ „
„ *nudiflora.* *Trewia nudiflora.*	Second grade rough plywood for interior work
Vateria indica.	Second grade plywood for interior work.
Zanthoxylum rhetsa.	First grade plywood for general utility purposes.

"Comparative Statement showing the strength Figures for compregnated wood made at the Forest Research Institute from Indian Timbers.

Species or type	Specific gravity	Tensile strength lbs./sq. in	Modulus of rupture lbs./sq.in	End comp. lbs./sq. in	Shear. Prl. lbs./sq. in	Shear. Perpen: lbs,/sq. in	Hardness. Prl. lbs.	Hardness. Perpen: lbs.	Hardness. End. lbs.	Brittle-ness ft. lbs.
Ordinary										
Semul	·333		6,100	3,450	780	570	380	440	540	4·0
Teak (Burma & Malabar)	·611		15.100	8,800	1400	1200	1160	1150	1100	6·5
Compregnated										
Semul	1·19 1·31	24000		22,000		2000	3700			9
Toon	1·24 1·31	36000	35,300	21,000	3800	5200	6300		5200	11·5
Hollock	1·25 1·30	42000	37,700	20,000	2500	4000	4500	—	4600	9·8
Zanthoxylum rhetsa	1·13		33,300	16,300	1775	2237	4140	4458	3885	19
Mulberry	1·25		28,400	16,700	3237	3930	6490	6075	5770	10
Salai	1·21		23,200	16,900	2435	4149	3245	3675	1550	5
Spruce	1·18	29000	25,200	14,000	1600	4000	3600		3100	14·5

Appendix IV.

Timber seasoning kilns Installed upto December, 1943.

Installation.	Approximate stacking capacity in cu. ft.	Remarks.
1. Central Provinces and South India.		
The Gun Carriage Factory, Jubbulpore.	28,500	...
The Government Sawmills, Khandwa, (C.P.).	6,000	Under erection.
The Government Sawmills, Seoni, (C.P.).	6,000	do.
Messrs. Curzon & Co., Madras.	1,000	Not yet completed.
Messrs. The Standard Furniture Co., Ltd., Kalai, (Malabar).	1,500	Used for the conditioning of plywood.
The P. W. D. Mechanical Workshops, Hyderabad, (Deccan).	1,500	...
The Osmania University Building Project, Hyderabad, (Deccan).	250	...
Bren Gun Factory, Hyderabad, (Deccan).	1,500	Under erection.
The Government Sawmill, Shimoga, (Mysore).	600	...
The Indian Industrial Development Trust, Ltd., Bangalore.	5,000	Three veneer drying tunnels.
Messrs. Hindustan Aircraft Co., Ltd., Bangalore.	500	Coal-gas heated kiln.
Messrs. Mysore Arts & Wood Works, Bangalore.	1,000	Require reconditioning.
The Development Deptt., Travancore State, Trivandrum.	250	...

9. Assam, Bengal, Bihar & Orissa, etc.

Messrs. The Assam Ry. & Trading Co., Ltd., Margherita, (Assam).	300	...
Messrs. The Surma Valley Sawmills, Bhangabazar, (Assam).	1,000	...
Messrs. C. Lazrus & Co., Calcutta.	1,000	...
Messrs. Bhattacharjee & Co., Calcutta.	4,000	...
Messrs. Mansfield & Sons, Calcutta.	2,000	...
Messrs. N. R. Ghose & Co., Calcutta.	1,000	Two furnace kilns.
The East Indian Railway Workshop, Lillooah.	7,500	Stopped at the present.
The Rifle Factory, Ishapore.	4,000	...
Messrs. The Gramophone Co., Ltd., Dum Dum.	300	...
Messrs. Tay Wood Works, Chakradharpur, Bihar.	1,000	...
Messrs. The Rohtas Industries, Dalmianagar, (Bihar).	1,000	Veneer drying tunnel.
Messrs. Tay Wood Works, Bamra, (Orissa).	1,000	...
Industries Deptt. Kathmandu, (Nepal).	250	...

3. Bombay.

The Government Sawmills, Dandeli, (Bombay).	250	...
Messrs. Sunderdas Sawmills, Bombay.	2,000	...
The Government Sawmills, Poona.	6,000	Under erection.
Messrs. The Malwa Timber Syndicate, Barwaha, (Indore).	500	...
Messers. Vithaldas Makanji, Navsari, (Baroda).	250	Furnace kiln.
Messrs. National Bobbin Works, Bombay.	—	Hot air kiln.

4. N. W. India and U. P.

The Divisional Forest Officer, Peshawar.	250	...

The Aircraft Timber Depot, Chheharta, Amritsar.	1,000	...
Messrs. The Indian Plywood Industries, Shahdara, Lahore.	500	...
Messrs. Bhiwani Cloth Mills Co., Ltd., Bhiwani, (Punjab).	1,000	...
Messrs. Delhi Cloth Mills & Co., Ltd., Delhi.	250	...
Messrs. The Plywood Factory, Daurala, (U. P.).	1,500	Furnace-Heated veneer drying tunnel.
Messrs. Plywood Products, Sitapur, (U. P.).	3,000	
Messrs. The Ganga Wood Works, Dehra Dun.	250	
Messrs. Jamna Industries, Dehra Dun.	1,000	Furnace heated veneer drying tunnel.
Messrs. The Indian Turpentine and Rosin Co., Ltd., Clutterbuck-ganj, Bareilly, (U. P.).	7,500	...
Messrs. Balrampur Industries, Balrampur.	1,000	...
The Government Harness and Saddlery Factory, Cawnpore.	1,000	...
The Mahabir Jute Mills Co., Ltd., Gorakhpur.	250	Under erection.
Radha Bobbin Factory, Muzaffarnagar.	250	Hot air kiln.

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(b) Scientific, Trade and Vernacular (including Burmese) Names of Species of Timbers etc.

(Excluding Appendices)

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